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August 15, 1980

Energy Research Abstracts

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UNITED STATES DEPARTMENT OF ENERGY

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ENERGY RESEARCH ABSTRACTS

Charles W. Duncan, Jr.
Secretary

Ruth M. Davis
Assistant Secretary
Resource Applications

Joseph G. Coyne
Manager
Technical Information Center

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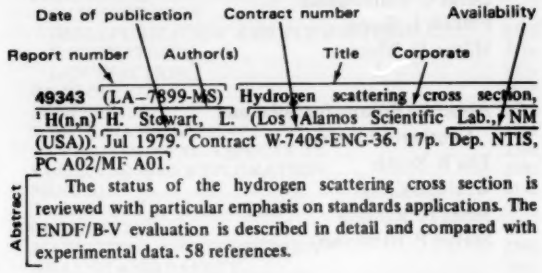
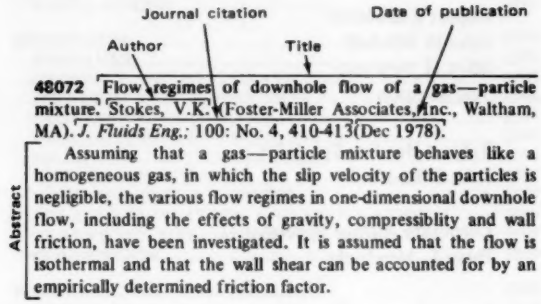

Date of publication
Contract number
Availability
Report number
Author(s)
Title
Corporate
49343 (LA–7899-MS) Hydrogen scattering cross section, $^1H(n,n)^1H$. Stewart, L. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.
Abstract
The status of the hydrogen scattering cross section is reviewed with particular emphasis on standards applications. The ENDF/B-V evaluation is described in detail and compared with experimental data. 58 references.


Journal citation
Date of publication
Author
Title
48072 Flow regimes of downhole flow of a gas—particle mixture. Stokes, V.K. (Foster-Miller Associates, Inc., Waltham, MA). J. Fluids Eng.; 100: No. 4, 410-413 (Dec 1978).
Abstract
Assuming that a gas—particle mixture behaves like a homogeneous gas, in which the slip velocity of the particles is negligible, the various flow regimes in one-dimensional downhole flow, including the effects of gravity, compressiblity and wall friction, have been investigated. It is assumed that the flow is isothermal and that the wall shear can be accounted for by an empirically determined friction factor.

•INDEXES TO *ENERGY RESEARCH ABSTRACTS*

Five indexes are provided for approaching the contents of each issue of *Energy Research Abstracts (ERA)*. These indexes are cumulated semiannually and annually. Each index is preceded by an introduction that details the organization of the index and the principles by which it was compiled. The reader is referred to these introductions for information not found in the index examples that follow.

•Corporate Index

Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

49343 (LA–7899-MS) Hydrogen scattering cross section, $^1H(n,n)^1H$. Stewart, L. **(Los Alamos Scientific Lab., NM (USA))**. Jul 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.

is indexed as:

Los Alamos Scientific Lab., NM (USA)
Advanced laser fusion target fabrication research and development proposal, 4:48249 (LA–7619-P)
Hydrogen scattering cross section, $^1H(n,n)^1H$, 4:49343 (LA–7899-MS)

•Author Index

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

Stewart, L., Hydrogen scattering cross section, $^1H(n,n)^1H$, 4:49343 (LA–7899-MS)
Stewart, M.D., *See* McInroy, J.F., 4:49280
Stewart, W., *See* Dean, J.W., 4:48543
Stimson, J., Reproduction, growth, and survival of Enewetak corals, 4:49200 (NVO–0703-1, pp 56-59)

•Subject Index

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

HYDROGEN 1 TARGET/NEUTRON REACTIONS
Hydrogen scattering cross section, $^1H(n,n)^1H$ (Above 100 keV, review), 4:49343 (LA–7899-MS)
HYDROGEN NITRATES
See NITRIC ACID
HYDROLOGY/RESEARCH PROGRAMS
Inventory of advanced energy technologies and energy conservation research and development: 1976-1978. Volume II. Prepared for the Committee on Science and Technology, U.S. House of Representatives, Ninety-Sixth Congress, 4:48749

•Contract Number Index

DOE technical report literature is indexed using contract numbers. This index contains the contract number with corresponding abstract and report numbers.

W-7405-ENG-36	**Los Alamos Scientific Lab., NM (USA)**	
	3:49698	LA-tr–78-45
	3:49857	LA–7224T
	3:49863	LA–7235-MS
W-7405-ENG-48	**California Univ., Livermore (USA). Lawrence Livermore Lab.**	
	3:49386	UCRL–52456
	3:49431	UCRL–52405

•Report Number Index

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

LA-		
7899-MS	**4:49343**	**Dep. NTIS, PC A02/MF A01**
LA-tr-		
78-69	**4:48158**	**Dep. NTIS, PC A03/MF A01**

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CONTENTS

Category	Page
COAL AND COAL PRODUCTS	2575
PROCESSING	2575
CARBONIZATION	2575
DESULFURIZATION AND PURIFICATION	2575
GASIFICATION	2576
LIQUEFACTION	2579
BY-PRODUCTS	2580
PROPERTIES	2580
WASTE MANAGEMENT	2581
ENVIRONMENTAL ASPECTS	2588
RESERVES AND EXPLORATION	2590
MINING	2590
TRANSPORT AND HANDLING	2591
COMBUSTION	2594
MARKETING AND ECONOMICS	2594
HEALTH AND SAFETY	2595
REGULATIONS	2595
PETROLEUM	2595
RESERVES	2595
GEOLOGY AND EXPLORATION	2596
DRILLING AND PRODUCTION	2596
PROCESSING	2597
PRODUCTS AND BY-PRODUCTS	2598
MARKETING AND ECONOMICS	2598
WASTE MANAGEMENT	2599
ENVIRONMENTAL ASPECTS	2599
POLICY, LEGISLATION, AND REGULATION	2599
TRANSPORT, PIPELINES, AND HANDLING	2599
COMBUSTION	2599
NATURAL GAS	2599
RESERVES	2599
GEOLOGY AND EXPLORATION	2599
DRILLING, PRODUCTION, AND PROCESSING	2599
PRODUCTS AND BY-PRODUCTS	2600
HEALTH AND SAFETY	2600
MARKETING AND ECONOMICS	2600
ENVIRONMENTAL EFFECTS	2600
TRANSPORT, PIPELINES, AND HANDLING	2600
STORAGE	2600
OIL SHALES AND TAR SANDS	2600
SITE GEOLOGY AND HYDROLOGY	2600
SITE GEOLOGY	2600
DRILLING, FRACTURING, AND MINING	2600
OIL PRODUCTION, RECOVERY, AND REFINING	2601
IN SITU METHODS, TRUE AND MODIFIED	2601
SURFACE METHODS	2603
REFINING	2603
PROPERTIES AND COMPOSITION	2603
DIRECT USES AND BY-PRODUCTS	2604
HEALTH AND SAFETY	2604
MARKETING AND ECONOMICS	2605
WASTE RESEARCH AND MANAGEMENT	2605
ENVIROMENTAL ASPECTS	2605
REGULATIONS	2606
NUCLEAR FUELS	2607
RESERVES	2607
EXPLORATION	2607
MINING	2610
FEED PROCESSING	2610
CENTRIFUGATION	2610
FUELS PRODUCTION AND PROPERTIES	2610
SPENT FUELS REPROCESSING	2610
TRANSPORT AND STORAGE	2611
MARKETING AND ECONOMICS	2612
WASTE MANAGEMENT	2612
WASTE PROCESSING	2612
WASTE DISPOSAL AND STORAGE	2613
ENVIRONMENTAL ASPECTS	2617
HEALTH AND SAFETY	2617
REGULATIONS	2618
ACCOUNTABILITY AND SAFEGUARDS	2618
FUSION FUELS	2618
PROCESSING	2618
FABRICATION AND TESTING	2618
REPROCESSING	2618
BY-PRODUCTS	2618
WASTE MANAGEMENT	2619
ISOTOPE AND RADIATION SOURCE TECHNOLOGY	2619
OTHER INDUSTRIAL USES	2619
ISOTOPIC POWER SUPPLIES	2619
DESIGN AND FABRICATION	2619
HYDROGEN	2619
PRODUCTION	2619
THERMOCHEMICAL PROCESSES	2619
CHEMISORPTION	2619
INDUSTRIAL AND COMMERCIAL USE	2619
PROPERTIES	2619
OTHER SYNTHETIC AND NATURAL FUELS	2619
PREPARATION	2619
CHEMICAL SYNTHESIS	2619
PREPARATION FROM WASTES OR BIOMASS	2620
PREPARATION	2620
CHEMICAL SYNTHESIS	2620
PREPARATION FROM WASTES OR BIOMASS	2620
PREPARATION	2620
SOLID WASTE FUELS	2623
HYDRO ENERGY	2623
ENVIRONMENTAL ASPECTS	2623
SOLAR ENERGY	2623
RESOURCES AND AVAILABILITY	2623
ECONOMICS	2623
ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS	2623
SOLAR ENERGY CONVERSION	2624
PHOTOVOLTAIC CONVERSION	2624
BIOMASS PRODUCTION AND CONVERSION	2627
PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION	2629
PHOTOVOLTAIC POWER PLANTS	2629
SOLAR THERMAL POWER PLANTS	2630
CENTRAL RECEIVER	2630
DISTRIBUTED COLLECTOR	2630
TOTAL ENERGY AND HYBRID SYSTEMS	2631
OCEAN THERMAL GRADIENT POWER PLANTS	2631
SOLAR RADIATION UTILIZATION	2632
SPACE HEATING AND COOLING	2632
AGRICULTURAL AND INDUSTRIAL PROCESS HEAT	2635
WATER HEATING	2639
SOLAR COLLECTORS AND CONCENTRATORS	2640
HEAT STORAGE	2643
GEOTHERMAL ENERGY	2643
RESOURCE STATUS AND ASSESSMENT	2643
USA	2643
NON-USA	2643

Category	Page
GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS	2644
USA	2644
GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY	2644
GEOCHEMICAL TECHNIQUES AND SURVEYS	2644
EXPLORATORY DRILLING AND WELL LOGGING	2644
LEGAL AND INSTITUTIONAL ASPECTS	2644
ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL	2644
BY-PRODUCTS	2645
POWER PLANT SYSTEMS AND COMPONENTS	2645
GEOTHERMAL ENGINEERING	2645
DRILLING TECHNOLOGY AND WELL HARDWARE	2645
GEOTHERMAL RESERVOIR AND WELL PERFORMANCE	2645
DIRECT ENERGY UTILIZATION	2645
TIDAL POWER	2646
WAVE ENERGY CONVERTERS	2646
WIND ENERGY	2646
ECONOMICS	2646
WIND ENERGY ENGINEERING	2646
TURBINE DESIGN AND OPERATION	2646
ELECTRIC POWER ENGINEERING	2646
POWER PLANTS AND POWER GENERATION	2646
COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS	2646
POWER CYCLES	2647
COMPONENTS	2647
WASTE HEAT UTILIZATION	2648
ECONOMICS	2648
OFF-PEAK ENERGY STORAGE	2648
FUELS	2648
ENVIRONMENTAL ASPECTS	2648
NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL	2649
SITE SELECTION AND LAND USE	2650
POWER TRANSMISSION AND DISTRIBUTION	2650
DC SYSTEMS	2651
SUPERCONDUCTING AND CRYOGENIC SYSTEMS	2651
NUCLEAR POWER PLANTS	2651
POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED	2651
POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED	2651
POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED	2651
POWER REACTORS, BREEDING	2652
REGULATION AND LICENSING	2653
ECONOMICS	2653
FUEL CYCLE	2653
NUCLEAR REACTOR TECHNOLOGY	2653
THEORY AND CALCULATION	2653
COMPONENTS AND ACCESSORIES	2654
FUEL ELEMENTS	2654
CONTROL SYSTEMS	2654
ENVIRONMENTAL ASPECTS	2654
RESEARCH, TEST, AND EXPERIMENTAL REACTORS	2655
REACTOR SAFETY	2655
ENERGY STORAGE	2656
MAGNETIC	2656
PUMPED HYDRO	2657
CAPACITOR BANKS	2657
FLYWHEELS	2657
THERMAL	2657
CHEMICAL	2657
BATTERIES	2657
DESIGN AND DEVELOPMENT	2657
PERFORMANCE AND TESTING	2659
MATERIALS, COMPONENTS, AND AUXILIARIES	2662
APPLICATIONS	2663
ENERGY MANAGEMENT AND POLICY	2664
ENERGY ANALYSIS AND MODELING	2664
ECONOMICS AND SOCIOLOGY	2664
ENVIRONMENT, HEALTH, AND SAFETY	2665
NATURAL RESOURCES	2665
RESEARCH, DEVELOPMENT, DEMONSTRATION, AND COMMERCIALIZATION	2665
NUCLEAR ENERGY	2665
TRANSPORT AND STORAGE	2665
WASTE HEAT UTILIZATION	2665
CONSERVATION	2666
SUPPLY, DEMAND, AND FORECASTING	2666
POLICY, LEGISLATION, AND REGULATION	2667
FOSSIL FUELS	2668
COAL	2668
PETROLEUM	2668
NATURAL GAS	2668
OIL SHALES AND TAR SANDS	2668
HYDROGEN AND SYNTHETIC FUELS	2668
ELECTRIC POWER	2668
ELECTRIC POWER GENERATION	2669
CONSUMPTION AND UTILIZATION	2669
SOLAR	2669
GEOTHERMAL	2669
OTHER	2669
ENERGY CONVERSION	2669
MHD GENERATORS	2669
DESIGN AND DEVELOPMENT	2669
PERFORMANCE AND TESTING	2670
MATERIALS, COMPONENTS, AND AUXILIARIES	2670
DUCT ENGINEERING AND FLUID DYNAMICS	2670
THERMOELECTRIC GENERATORS	2671
MATERIALS, COMPONENTS, AND AUXILIARIES	2671
APPLICATIONS	2671
THERMIONIC CONVERTERS	2671
DESIGN AND DEVELOPMENT	2671
FUEL CELLS	2671
DESIGN AND DEVELOPMENT	2671
PERFORMANCE AND TESTING	2671
MATERIALS, COMPONENTS, AND AUXILIARIES	2672
APPLICATIONS	2672
ELECTROMECHANICAL CONVERTERS	2672
ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION	2672
BUILDINGS	2672
RESIDENTIAL BUILDINGS	2673
OFFICE BUILDINGS	2674
SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS	2674
COMMERCIAL AND INDUSTRIAL BUILDINGS	2674
TRANSPORTATION	2674
AIR AND AEROSPACE	2675
RAILWAY	2675
LAND AND ROADWAY	2676
INDUSTRY AND AGRICULTURE	2677
ENERGY SOURCES	2677
MATERIALS	2677
EQUIPMENT AND PROCESSES	2678
WASTE HEAT RECOVERY AND UTILIZATION	2679
INDUSTRIAL WASTE MANAGEMENT	2680
MUNICIPALITIES AND COMMUNITY SYSTEMS	2681
PUBLIC UTILITIES	2681
MUNICIPAL WASTE MANAGEMENT	2681

Category	Page
EDUCATION AND PUBLIC RELATIONS	2682
ADVANCED AUTOMOTIVE PROPULSION SYSTEMS	2682
INTERNAL COMBUSTION ENGINES	2682
SPARK-IGNITION	2682
DIESEL	2682
TURBINE	2683
EXTERNAL COMBUSTION ENGINES	2683
ELECTRIC-POWERED SYSTEMS	2683
HYBRID SYSTEMS	2684
FLYWHEEL PROPULSION	2684
EMISSION CONTROL	2684
ALTERNATIVE FUELS	2685
MATERIALS	2685
METALS AND ALLOYS	2685
PREPARATION AND FABRICATION	2685
STRUCTURE AND PHASE STUDIES	2687
MECHANICAL PROPERTIES	2688
PHYSICAL PROPERTIES	2688
CORROSION AND EROSION	2690
RADIATION EFFECTS	2691
CERAMICS, CERMETS, AND REFRACTORIES	2691
PREPARATION AND FABRICATION	2691
STRUCTURE AND PHASE STUDIES	2692
MECHANICAL PROPERTIES	2692
PHYSICAL PROPERTIES	2692
CORROSION AND EROSION	2692
RADIATION EFFECTS	2693
COMPOSITE MATERIALS	2693
PREPARATION AND FABRICATION	2693
PHYSICAL PROPERTIES	2693
POLYMERS AND PLASTICS	2693
PREPARATION AND FABRICATION	2693
MECHANICAL PROPERTIES	2693
PHYSICAL PROPERTIES	2694
DEGRADATION AND EROSION	2694
OTHER MATERIALS	2694
PREPARATION AND MANUFACTURE	2694
STRUCTURE AND PHASE STUDIES	2694
PROPERTIES	2695
CORROSION, EROSION, AND DEGRADATION	2697
RADIATION EFFECTS	2697
CHEMISTRY	2697
ANALYTICAL AND SEPARATIONS CHEMISTRY	2697
ACTIVATION AND NUCLEAR REACTION PROCEDURES	2697
CHEMICAL PROCEDURES	2698
RADIOMETRIC AND RADIOCHEMICAL PROCEDURES	2698
SPECTRAL PROCEDURES	2698
SEPARATION PROCEDURES	2698
INORGANIC AND PHYSICAL CHEMISTRY	2699
CHEMICAL AND PHYSICOCHEMICAL PROPERTIES	2699
ISOTOPE EXCHANGE AND ISOTOPE SEPARATION	2699
ORGANIC CHEMISTRY	2699
CHEMICAL AND PHYSICOCHEMICAL PROPERTIES	2699
ISOTOPE EFFECTS	2699
ISOTOPE EXCHANGE AND ISOTOPE SEPARATION	2699
ELECTROCHEMISTRY	2699
PHOTOCHEMISTRY	2699
RADIATION CHEMISTRY	2700
RADIOCHEMISTRY AND NUCLEAR CHEMISTRY	2700
PROPERTIES OF RADIOACTIVE MATERIALS	2700
COMBUSTION, PYROLYSIS, AND HIGH-TEMPERATURE CHEMISTRY	2700
ENGINEERING	2700
FACILITIES AND EQUIPMENT	2700
CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES	2701
PROTECTIVE STRUCTURES AND EQUIPMENT	2701
HANDLING EQUIPMENT AND PROCEDURES	2702
SHIPPING CONTAINERS	2702
MINING AND DRILLING EQUIPMENT AND FACILITIES	2702
LASERS	2702
HEAT TRANSFER AND FLUID FLOW	2703
MATERIALS TESTING	2703
SAFETY ENGINEERING	2703
VACUUM ENGINEERING	2703
ELECTRONIC CIRCUITS AND DEVICES	2704
COMBUSTION SYSTEMS	2704
UNDERGROUND ENGINEERING	2704
MARINE ENGINEERING	2704
POLLUTION CONTROL EQUIPMENT	2704
POWER CYCLES	2705
STIRLING	2705
PARTICLE ACCELERATORS	2705
BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS	2705
AUXILIARIES AND COMPONENTS	2705
ION SOURCES	2705
EXPERIMENTAL FACILITIES AND EQUIPMENT	2705
STORAGE RINGS	2706
INSTRUMENTATION	2706
RADIATION INSTRUMENTATION	2706
GENERAL DETECTORS AND MONITORS	2706
RADIATION DOSEMETERS	2706
NUCLEAR SPECTROSCOPIC INSTRUMENTATION	2706
HIGH ENERGY PHYSICS INSTRUMENTATION	2707
RADIOMETRIC INSTRUMENTS	2707
MISCELLANEOUS INSTRUMENTS	2707
WELL LOGGING INSTRUMENTATION	2708
EXPLOSIONS AND EXPLOSIVES	2708
CHEMICAL	2708
WEAPONRY	2709
EXPLOSION DETECTION	2709
ENVIRONMENTAL SCIENCES, ATMOSPHERIC	2709
BASIC STUDIES	2709
CHEMICALS MONITORING AND TRANSPORT	2709
RADIOACTIVE MATERIALS MONITORING AND TRANSPORT	2714
SITE RESOURCE AND USE STUDIES	2714
REGULATIONS	2714
ENVIRONMENTAL SCIENCES, TERRESTRIAL	2715
BASIC STUDIES	2715
CHEMICALS MONITORING AND TRANSPORT	2715
RADIOACTIVE MATERIALS MONITORING AND TRANSPORT	2715
SOIL	2716
SITE RESOURCE AND USE STUDIES	2716
ENVIRONMENTAL SCIENCES, AQUATIC	2716
BASIC STUDIES	2716
CHEMICALS MONITORING AND TRANSPORT	2716
RADIOACTIVE MATERIALS MONITORING AND TRANSPORT	2717
WATER	2717
AQUATIC ECOSYSTEMS AND FOOD CHAINS	2717
THERMAL EFFLUENTS MONITORING AND TRANSPORT	2717
SITE RESOURCE AND USE STUDIES	2717
REGULATIONS	2718
ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES	2718
SOCIAL AND ECONOMIC STUDIES	2718
ASSESSMENT OF ENERGY TECHNOLOGIES	2718

Category	Page
ENVIRONMENTAL IMPACT STATEMENTS	2718
BIOMEDICAL SCIENCES, BASIC STUDIES	2718
BEHAVIORAL BIOLOGY	2718
BIOCHEMISTRY	2719
TRACER TECHNIQUES	2722
CYTOLOGY	2723
TRACER TECHNIQUES	2724
GENETICS	2724
METABOLISM	2725
TRACER TECHNIQUES	2725
MEDICINE	2725
UNSEALED RADIONUCLIDES IN DIAGNOSTICS	2725
EXTERNAL RADIATION IN DIAGNOSTICS	2725
EXTERNAL RADIATION IN THERAPY	2726
MICROBIOLOGY	2726
PATHOLOGY	2726
PHYSIOLOGICAL SYSTEMS	2726
TRACER TECHNIQUES	2727
PUBLIC HEALTH	2727
AGRICULTURE AND FOOD TECHNOLOGY	2727
BIOMEDICAL SCIENCES, APPLIED STUDIES	2727
RADIATION EFFECTS ON BIOCHEMICALS	2727
IN VITRO	2727
IN MICROORGANISMS	2727
IN MAN	2727
RADIATION EFFECTS ON CELLS	2727
EXTERNAL SOURCE	2727
RADIATION EFFECTS ON MICROORGANISMS	2728
BASIC STUDIES	2728
RADIATION EFFECTS ON ANIMALS	2729
MAN	2729
VERTEBRATES	2729
RADIONUCLIDE EFFECTS - INTERNAL SOURCE	2729
MAN	2729
ANIMALS	2729
NUCLIDE KINETICS AND TOXICOLOGY	2729
MAN	2729
ANIMALS	2730
THERMAL EFFECTS	2730
MICROORGANISMS	2730
INVERTEBRATES	2730
VERTEBRATES	2731
CHEMICALS METABOLISM AND TOXICITY	2731
CELLS	2731
MICROORGANISMS	2731
PLANTS	2731
INVERTEBRATES	2732
VERTEBRATES	2732
MAN	2732
OTHER ENVIRONMENTAL POLLUTANT EFFECTS	2733
GEOSCIENCES	2733
GEOLOGY AND HYDROLOGY	2733
GEOPHYSICS	2733
SEISMOLOGY AND TECTONICS	2733
GEOPHYSICAL SURVEY METHODS	2734
MINERALOGY, PETROLOGY, AND ROCK MECHANICS	2734
GEOCHEMISTRY	2735
PHYSICS RESEARCH	2735
ASTROPHYSICS AND COSMOLOGY	2735
STARS	2735
SOLAR PHENOMENA	2735
COSMOLOGY	2736
PLANETARY PHENOMENA	2736
ATMOSPHERIC PHYSICS	2736
AURORAL AND IONOSPHERIC PHENOMENA	2736
MAGNETOSPHERIC PHENOMENA	2736
ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS	2736
BEAMS AND THEIR REACTIONS	2736
ATOMIC AND MOLECULAR PROPERTIES	2737
POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES	2737
COLLISION PHENOMENA	2738
ATOMIC AND MOLECULAR THEORY	2738
GENERAL FLUID DYNAMICS	2739
PROPERTIES AND STRUCTURE OF FLUIDS	2739
PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL	2739
ELECTROMAGNETIC INTERACTIONS	2739
WEAK INTERACTIONS	2740
STRONG BARYON-INDUCED INTERACTIONS	2741
STRONG MESON-INDUCED INTERACTIONS	2741
PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL	2741
GENERAL	2741
ELECTROMAGNETIC INTERACTIONS	2742
WEAK INTERACTIONS	2742
STRONG INTERACTIONS, GENERAL	2742
STRONG INTERACTIONS, BARYON NO.=0	2742
STRONG INTERACTIONS, BARYON NO. GREATER THAN 1	2743
PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES	2743
GENERAL	2743
APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS	2743
FIELD THEORY	2743
SCATTERING THEORY	2744
PHYSICS RESEARCH	2744
NUCLEAR PHYSICS	2744
EXPERIMENTAL TECHNIQUES	2744
NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL	2744
NUCLEAR REACTIONS AND SCATTERING	2744
NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL	2744
ENERGY LEVELS AND TRANSITIONS	2744
NUCLEAR REACTIONS AND SCATTERING	2744
NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL	2745
NUCLEAR REACTIONS AND SCATTERING	2745
NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL	2745
ENERGY LEVELS AND TRANSITIONS	2745
NUCLEAR REACTIONS AND SCATTERING	2745
NUCLEAR PROPERTIES AND REACTIONS, A=20-38, THEORETICAL	2746
ENERGY LEVELS AND TRANSITIONS	2746
NUCLEAR REACTIONS AND SCATTERING	2746
NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL	2746
ENERGY LEVELS AND TRANSITIONS	2746
MOMENTS AND SPIN	2746
NUCLEAR REACTIONS AND SCATTERING	2746
NUCLEAR PROPERTIES AND REACTIONS, A=39-58, THEORETICAL	2747
NUCLEAR REACTIONS AND SCATTERING	2747
NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL	2747
ENERGY LEVELS AND TRANSITIONS	2747
NUCLEAR REACTIONS AND SCATTERING	2747
RADIOACTIVE DECAY	2747
NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL	2747
RADIOACTIVE DECAY	2747
ENERGY LEVELS AND TRANSITIONS	2747
NUCLEAR REACTIONS AND SCATTERING	2747
RADIOACTIVE DECAY	2747
NUCLEAR REACTIONS AND SCATTERING	2747
NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL	2748
ENERGY LEVELS AND TRANSITIONS	2748

Category	Page
MOMENTS AND SPIN	2748
NUCLEAR REACTIONS AND SCATTERING	2748
NUCLEAR PROPERTIES AND REACTIONS, A=150-189, THEORETICAL	2748
ENERGY LEVELS AND TRANSITIONS	2748
NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL	2748
RADIOACTIVE DECAY	2748
ENERGY LEVELS AND TRANSITIONS	2748
NUCLEAR REACTIONS AND SCATTERING	2749
NUCLEAR PROPERTIES AND REACTIONS, A=190-219, THEORETICAL	2749
MASS, ABUNDANCE, AND BINDING ENERGY	2749
NUCLEAR REACTIONS AND SCATTERING	2749
SPONTANEOUS AND INDUCED FISSION	2749
NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL	2749
MASS, ABUNDANCE, AND BINDING ENERGY	2749
RADIOACTIVE DECAY	2749
ENERGY LEVELS AND TRANSITIONS	2749
NUCLEAR REACTIONS AND SCATTERING	2750
NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL	2750
MASS, ABUNDANCE, AND BINDING ENERGY	2750
SPONTANEOUS AND INDUCED FISSION	2750
NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL	2750
RADIOACTIVE DECAY	2750
ENERGY LEVELS AND TRANSITIONS	2750
NUCLEAR REACTIONS AND SCATTERING	2750
SPONTANEOUS AND INDUCED FISSION	2750
NUCLEAR THEORY	2750
NUCLEAR STRUCTURE	2750
NUCLEAR MATTER	2751
NUCLEAR REACTIONS AND SCATTERING	2751
NUCLEAR MOMENTS AND SPIN	2751
NUCLEAR MODELS	2751
RADIATION AND SHIELDING PHYSICS	2752
RADIATION PHYSICS	2752
SHIELDING CALCULATIONS AND EXPERIMENTS	2752
NEUTRON INTERACTIONS WITH MATTER	2752
MEDICAL PHYSICS	2752
DOSIMETRY	2752
SOLID STATE PHYSICS	2752
SOLID STATE PLASMA	2754
SUPERCONDUCTIVITY	2754
GENERAL THEORY	2754
ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA	2754
THEORETICAL PHYSICS	2754
CLASSICAL AND QUANTUM MECHANICS	2754
RELATIVITY AND GRAVITATION	2754
OPTICS	2754
MATHEMATICAL PHYSICS	2755
FUSION ENERGY	2755
PLASMA RESEARCH	2755
PLASMA CONFINEMENT AND HEATING	2755
PLASMA DIAGNOSTICS	2756
PLASMA KINETICS - GENERAL	2757
PLASMA KINETICS - EXPERIMENTAL	2757
PLASMA KINETICS - THEORETICAL	2758
PLASMA PRODUCTION	2759
PLASMA INSTABILITIES	2759
PLASMA WAVE PHENOMENA	2760
FUSION POWER PLANT TECHNOLOGY	2761
BLANKET ENGINEERING	2761
MAGNET COILS AND FIELDS	2761
POWER SUPPLIES, ENERGY STORAGE	2762
COOLING SYSTEMS	2763
HEATING AND FUELING SYSTEMS	2763
TRITIUM PROCESSING, ENVIRONMENT AND SAFETY	2763
INERTIAL CONFINEMENT TECHNOLOGY	2764
COMPONENT DEVELOPMENT AND MATERIALS TESTING	2765
GENERAL AND MISCELLANEOUS	2767
MANAGEMENT	2767
MATHEMATICS AND COMPUTERS	2767
INFORMATION HANDLING	2769
CIVILIAN DEFENSE	2769
CORPORATE INDEX	1C
AUTHOR INDEX	19A
SUBJECT INDEX	51S
CONTRACT NUMBER INDEX	151CN
REPORT NUMBER INDEX	157R
ERRATA	173E

Volume 5, Number 15, August 15, 1980

ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

PROCESSING

CARBONIZATION

23411 **Method of producing form coke.** Weber, H.; Beckmann, F. (to Firma Carl Still; Eschweiler Bergwerksverein). US Patent 4,181,502. 1 Jan 1980. Priority date 4 Nov 1977, German, Federal Republic of (F.R. Germany), 6p.

A method of producing form coke, particularty metallurgical coke for a blast furnace, comprises mixing at least two finely ground coal components, a non-caking component and a caking component, and heating the mixture at temperatures corresponding approximately to the softening point of the caking coal component. The caking component is a bituminous coal, and the non-caking component comprises an oil coke containing little volatile matter. The heated mixture is carbonized and pressed to form a briquetted form coke, and the form coke is subsequently hardened.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 23431, 23436, 23439, 23444, 23790, 24032, 24033

23412 (FE—2709-T1) **Investigation of high velocity wedge separator for particle removal in coal gasification plants. Quarterly report.** Linhardt, H.D.; Beveridge, J.H.; Boone, C.G.; Bosco, G.B. Jr. (Linhardt and Associates, Inc., Newport Beach, CA (USA)). 31 Jul 1979. Contract EF-77-C-01-2709. 28p. NTIS, PC A03/MF A01.

Phase IA and Phase II are proceeding concurrently in order to demonstrate feasibility and performance of the most promising high velocity particle separator configuration for coal gasification plants. The Phase IA investigation experienced difficulty with particle samples caking and agglomerating and subsequently obscuring AAM operations. Further particle investigation is necessary in order to eliminate the ambient particle problem, which is not present at high temperature and high pressure. The HTPS-1 hot test runs at 1800°F and 360 psia have indicated a collection efficiency of eta = 0.87 for the particle range $0.20 < 2\sigma < 10\mu$, which is superior to all state-of-the-art cyclone devices for the particle range investigated. Additional hot firings are scheduled in order to substantiate the full performance potential of the HTPS-1 and the HTPS-2.

23413 (METC/SP—79/10(Pt.1), pp 205-214) **Glass-fly ash from a new hot gas clean-up process.** Fedarko, W. (Dept. of Energy, Washington, DC); McCreight, L.R.; Rauch, H.W. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

It was postulated that hot gas cleanup problems can be minimized, if not eliminated, by the use of glass to capture the particles and perhaps the vaporized alkalis. At possible future gas turbine operating temperatures of about 1300 to 1400°C the glass may be entirely composed of the fly ash in a molten condition. At the present desulfurization and gas turbine operating temperatures however, lower temperature waste container glasses are used to initiate and maintain the cleaning process which consists of two separate processes; (1) impaction, in which a glass coating on the walls of a duct and of a labyrinth of plates serve to capture the particles from the gases and (2) scrubbing in a shallow bath of molten glass. In both steps of this continuous process, the fly ash particles are trapped and dissolved thereby adding to the glass by-products which can be drained from the collector and possibly used for numerous applications such as aggregate in paving and building materials, fiber and foam glass insulation, containers and wall tiles. If the waste is not used, it is in any case more easily transported and dumped due to its greater density. It is also expected to be of very low solubility due to the refractory nature of the container glass-fly ash mixture.

23414 (PB—301104) **Sulfur fixation during coal gasification. Final report 1 March 1975-28 February 1978.** Schuhmann, R. Jr; Spitzer, R.H.; Mehta, A.J. (Purdue Univ., Lafayette, IN (USA). School of Materials Engineering). 15 Dec 1978. 107p. NTIS, PC A06/MF A01.

Research activities are reported on the development of basic engineering data for design of a coal gasification process in which the sulfur is fixed and separated in chemical combination with iron. Thermodynamic calculations and phase equilibrium studies were conducted for the ternary condensed systems Fe-O-S and Fe-C-S, and for equilibria of condensed phases in these systems with gases containing various combinations of C, O, H, and S. These studies showed that iron oxides, metallic iron, and iron silicates should be effective sulfur fixation agents over wide ranges of gas compositions and gasification temperature, both below and above the melting point of iron sulfide. A steady state, isothermal, fixed-bed laboratory technique was developed for quantitative study of the kinetics of reactions of gases with particulate solids. This procedure was used to measure specific reaction rate and rate constants for sulfur fixation with iron as a function of temperature and iron oxide particle size. A jet-fluidized reactor, constructed and patented by the principal investigator, provided a successful simulation of combined gasification and sulfur fixation with iron at temperatures for which the sulfur fixation product was a molten iron oxysulfide. Potentially useful applications of the data of this investigation to process and flowsheet design are discussed.

23415 **Holmes-Stretford process for desulfurization of tail gases from acid-gas systems.** Vasan, S. (Peabody Process Systems, Inc., Stamford, CT). pp 157-161 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

The treatment of tail gases from acid-gas systems has become an important process step in the last few years with the emergence of new EPA regulations that require tail-gas emissions to be cleaned up to the 99.9% removal level of input sulfur content. Prior to these regulations, a Claus unit with three catalyst beds was sufficient to achieve cleanup of up to 95% removal level. The new regulations made it mandatory that even a Claus unit be followed up by a tail-gas cleanup unit. Economic desulfurization of gases is becoming important in several areas. The need for desulfurization of acid-gas streams arises not only from amine-treating units in refineries or sour gas treating units but also in coal gasification projects. Many of the recent coal gasification as well as sour gas desulfurization projects in the US have chosen the one-step Holmes-Stretford process to desulfurize the raw gas, not only for its economic advantage over multistep processes but also for its high efficiency, compactness, and simplicity of operation. Desulfurization of gases has demanded from the chemical engineer ingenuity and process innovations. This challenge has been met by developing the Holmes-Stretford process into a reliable and acceptable process scheme.

23416 **Final sulfur removal in ammonia from coal plants.** Allen, D.W. (United Catalysts, Inc., Louisville, KY). pp 162-164 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

Activated carbons and zinc oxides are but two of the alternatives available for final sulfur removal. Partial oxidation plants have been operated using a number of desulfurization systems for final

sulfur removal. The overall economics of the particular process will dictate the type of sulfur removal system or systems used.

GASIFICATION

REFER ALSO TO CITATION(S) 23414, 23415, 23416, 23458, 23515, 23531, 23766, 23778, 23779, 23780, 23781, 23782, 23783, 23784, 23785, 23787, 23788, 23790, 23791, 23792, 24370, 24787

23417 (ANL—80-12) **Materials technology for coal-conversion processes. Nineteenth report, July-December 1979.** (Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 95p. Dep. NTIS, PC A05/MF A01.

Analysis of refractories exposed to slag attack during the last 500-h test run shows that complex spinels formed at the slag-refractory interfaces of the chrome-spinel, alumina-chromia, and alumina refractories. Silicon carbide refractories reacted with iron oxides and produced a low-melting ferrosilicon alloy and CO or CO_2 gas. A high-temperature ultrasonic erosion scanner was installed and field tested at the Solvent Refined Coal (SRC) coal-liquefaction plant. Automatic data acquisition was accomplished through direct coupling to the SRC on-site computer. The scanner has detected erosive wear in the SRC erosion-corrosion test loop. Successful field performance of the erosion scanner was also demonstrated at the Morgantown Energy Technology Center gasifier. The scanner collected data on erosive-wear rate throughout a 400-h run. Corrosion studies continued, with emphasis on Fe-Ni-Cr alloys. Experimental results show that alloy chemistry has only a minor influence on the type and morphology of scales. Further, these results suggest that as exposure time increases, a greater oxygen partial pressure is required for breakaway corrosion. Synergistic erosion-corrosion studies conducted in a simulated coal-gasification atmosphere at 815°C, with 150-μm Al_2O_3 at 22 m/s as erodant, show that Incoloy 800 was the most corrosion-resistant alloy tested and 1015 carbon steel the least resistant. These results duplicate those of a previous test under the same conditions. Failure analysis activities are described.

23418 (DOE/ET/10254—T2) **Test and evaluate the TRI-GAS low-Btu coal gasification process. Quarterly report, January-March 1980.** (Bituminous Coal Research, Inc., Monroeville, PA (USA)). Apr 1980. Contract AC01-78ET10254. 17p. NTIS, PC A02/MF A01.

New silicon carbide liners were cast for all three reactor vessels. The new liners will facilitate installation of the new reactor heaters and make possible a better seal between the heaters and vessel internals. Globar heating elements were received, cut to length, and installed on the new silicon carbide vessel liners in States 2 and 3. The heater for Stage 1 was reassembled on the new silicon carbide liner and installed in the vessel. Preliminary tests were made following the installation of the silicon carbide liners and heaters. The Stage 2 heater failed open, due to poor contact, after a few hours of testing. This problem was solved by nickel plating the ends of the Globars and using graphite packing to cushion the connector set screws.

23419 (EPRI-AF—1242) **Design properties of steels for coal conversion vessels. Interim report.** McCabe, D.E.; Landes, J.D. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). Dec 1979. 39p. Dep. NTIS, PC A03/MF A01.

The present project was undertaken to develop a quantitative fracture mechanics technology base for 2-1/4 Cr-1 Mo steel with a variety of metallurgical and environmental conditions that may be typically encountered in coal liquefaction and gasification. This is a topical report covering the development of equipment needed to conduct fracture mechanics type tests in simulated coal conversion environments. The conditions are: 6% H_2S - bal. H_2 gas delivered under flowing conditions to a test chamber operating at 727°K (850°F) and pressures up to 24.1 MPa (3500 psi). The systematic development scheme is described, covering both initial design concepts and subsequent modifications to make a viable working test system.

23420 (FE—0208-T1) **Studies of phenolic compound decomposition under Synthane gasifier conditions. Final report.** Fillo, J.P.; Massey, M.J. (Carnegie-Mellon Univ., Pittsburgh, PA (USA)). Oct 1979. Contract EW-78-C-22-0208. 85p. NTIS, PC A05/MF A01.

Phenolic effluents are produced during the gasification of coal. Process operating conditions such as temperature, vapor residence time, reaction environment, coal heating rate, and gas-solid contacting (which vary significantly both within and between processes) determine observed production patterns. Phenolic compounds are very susceptible to thermal and catalytic cracking in typical gasification environments. The present experimental program was conducted to determine the pattern of phenolic compound decomposition under typical Synthane PDU gasification conditions. Bench-scale experiments were conducted at atmospheric pressure in a steam/synthesis gas atmosphere to study homogenous gas phase ortho-cresol decomposition characteristics, and quantify phenol decomposition in the presence of gasifier solids. Major conclusions are: (1) Phenols typically formed during coal gasification decompose via successive dealkylation of higher phenol homologues (i.e., xylenols and cresols). (2) The rate limiting step in the decomposition of phenols during coal gasification is decomposition of the compound phenol. (3) The presence of char solids enhances phenol decomposition rates by 2 to 3 orders of magnitude over those seen during homogeneous gas phase reaction under typical gasifier thermal conditions. (4) Methane content of the reaction gas is stable under conditions conducive to achieving substantial levels of phenolic compound decomposition. Data of this nature provide information necessary for projecting phenolic effluent production characteristics from pilot- to commercial-scale facilities, as well as for controlling their production during coal gasification processing.

23421 (FE—1514-97) **Advanced coal gasification system for electric power generation. Quarterly progress report, October 1-December 31, 1978.** (Westinghouse Electric Corp., Madison, PA (USA). Advanced Coal Conversion Dept.). 30 Jun 1979. Contract EF-77-C-01-1514. 137p. NTIS, PC A07/MF A01.

The operation of the PDU focused on testing of the single-stage gasifier system using numerous coal feedstocks and oxygen and steam as the gasification media. The four tests run were TP-018-5 and TP-019-1, -2, and -3. Operating summaries with the significant results of these tests are described. Test TP-018-5 was the last shakedown test in an experimental test grid with highly caking Pittsburgh seam coal. This test grid was designed to show the effects of varying the oxygen and steam flows on the higher heating value of the product gas on a dry basis. In addition, a slight modification to the oxidant tube geometry was examined during this test as well as in tests TP-019-1 and TP-019-2. The operability of the oxygen-blown gasifier on more highly reactive feedstocks was explored in the TP-019 test series. Three coals successfully gasified ranged from Montana Rosebud sub-bituminous coal to two highly volatile bituminous B rank coals: Indiana No. 7 and Western Kentucky No. 9. A total of 440 hours of hot operation was achieved during this test series, almost all of which was performed on direct coal feed to the oxygen-blown gasifier. More than 25 tons of Montana Rosebud coal, 43 tons of Indiana No. 7 coal, and 42 tons of Western Kentucky No. 9 coal were processed during tests TP-019-1, -2, and -3.

23422 (FE—2012-083) **Pipeline gas demonstration plant. Phase I. Quarterly technical progress report, September-November 1979.** Eby, R.J. (Illinois Coal Gasification Group, Chicago (USA)). Dec 1979. Contract EF-77-C-01-2012. 57p. NTIS, PC A04/MF A01.

Work has continued on Phase I, Stage 1 of the Pipeline Gas Demonstration Plant Program: demonstration plant process design, site evaluation and selection, demonstration plant environmental analysis, materials and licenses, technical support, long lead procurement list, and project management. Work has been initiated in the definitive design of the non-process areas. During this past quarter, the following Major Contract Deliverables were submitted to DOE: Record Environmental Analysis Report, Permits and Licenses Plan, and Network Analysis Document and Addenda 1 and 2. No critical obstacles have been experienced and the work in all tasks has progressed satisfactorily. The major work activity has been directed toward the baselining of the Demonstration Plant process areas and the subsequent completion of the definitive process design. A significant part of this effort will be the preparation of the Demonstration Plant Process Design Report and Design Analysis Report. All other authorized work activity under the Contract is continuing, within the constraint of available funds, toward the completion of Phase I.

23423 (FE—2338-14) **Development of a modular software system for the dynamic simulation of coal conversion plants. Final report.** Schiesser, W.E.; Stein, F.P.; Johnson, S.H.; Caram, H.S.; Dissinger, G.R. (Lehigh Univ., Bethlehem, PA (USA)). Sep 1979. Contract EX-76-C-01-2338. 141p. NTIS, PC A07/MF A01.

A code was written in transportable (standard) FORTRAN IV for the numerical integration of systems of ordinary and partial differential equations (ODE/PDEs) based on the numerical method of lines. Thus the code can be used to simulate combinations of discrete units in a coal conversion plant, modeled by ODEs, and distributed units, modeled by PDEs. Examples of the former include perfectly mixed units, and of the latter, units with a significant spatial distribution such as tubular reactors and heat exchangers. The user states the problem by writing a set of three subroutines that define the initial conditions of the problem system, the differential equations, and the output requirements (e.g., printed, plotted output of the solution). The temporal integration (i.e., integration through time which is the central feature of dynamic simulation) is done by a user-selected integration algorithm from a set of 16 integrators, including both explicit and implicit integrators. A conceptual flowsheet was followed in applying the general-purpose simulator to coal processing units. Dynamic models were prepared and successfully executed for six major sections of the ICGG process, each of which consists of several interconnected units [(1) pyrolysis section, (2) gasifier-combustor-lift tube, (3) hydrogen plant, (4) hydrotreating section, (5) carbon dioxide removal section, and (6) bulk methanation section]

and for two stand-alone units in the process (steam reformer and compressor). Nearly all of the process models are first-principle models based on material balances, energy balances, and chemical rate-of-reaction equations.

23424 (FE—2469-48) **Experimental program for the development of peat gasification. Task 2. Hydrogasification. Task 3. Fluidized-bed tests. Interim report No. 7, October 1, 1978-July 31, 1979.** (Institute of Gas Technology, Chicago, IL (USA)). Feb 1980. Contract EX-76-C-01-2469. 72p. NTIS, PC A04/MF A01.

Thirty tests were conducted in an entrained-flow hydrogasification process development unit (PDU) with Minnesota, North Carolina, and Maine peats to determine the effects of temperature, hydrogen partial pressure, residence time, and particle size on the product distribution and yields. These tests were conducted at temperatures of about 1000° to 1500°F, hydrogen partial pressures of 0 to 250 psia, residence times of 2 to 30 seconds, and particle sizes of -10 + 100, -10 + 20, and -60 + 120 mesh. The results show that overall carbon conversion and hydrocarbon gas yield for the Minnesota peat are about 20% and 50% higher than those for North Carolina and Maine peats, respectively. The liquid fuel yields from all three peats are similar. Seventeen gasification tests were conducted in a 6-inch-diameter fluidized-bed reactor with steam and oxygen. These tests were conducted with raw peat as well as with chars of the peats from Minnesota, North Carolina, and Maine. The objectives of these tests were to determine the effects of temperature, pressure, and steam/feed carbon mole ratios on the gasification characteristics of peats and peat chars. The tests were conducted at pressures, temperatures, steam/feed carbon mole ratios, and fluidization velocities in the ranges of 123 to 544 psia, 1600° to 1850°F, 0.7 to 2.6, and 0.4 to 1.0 ft/s, respectively. Carbon conversions as high as 96% were achieved. Tests were also conducted to determine the effect of temperature and fluidization velocity on the sintering characteristics of peat chars. All the data from hydrogasification PDU tests and char gasification PDU tests have been correlated. The unified kinetic description of the three peats is presented.

23425 (FE—2729-8) **Alloy catalysts with monolith supports for methanation of coal-derived gases. Quarterly technical progress report, June 21-September 20, 1979.** Bartholomew, C.H. (Brigham Young Univ., Provo, UT (USA)). 5 Oct 1979. Contract EF-77-S-01-2729. 40p. NTIS, PC A03/MF A01.

Kinetic studies of monolithic Ni/Al_2O_3 revealed a shift in activation energy for methanation of CO above 573 K. In kinetic studies at high pressure rapid deactivation was observed for low loading monolithic catalysts. A one-dimensional computer model for methanation over monolithic catalysts was developed to provide insight into experimental conversion vs. temperature data taken in this laboratory. A new method for qualitatively determining sulfur on poisoned catalysts was developed and tested. Metal crystallite size distribution data obtained from transmission electron micrograph (TEM) studies on Ni/silica catalysts suggest that sintering may occur by both crystallite and atomic migration mechanisms. TEM studies of 3% Ni/TiO_2 reveal the presence of raft-like crystallites. These and other accomplishments are reported and discussed.

23426 (FE—2762-7) **Formation and control of fuel-nitrogen pollutants in catalytic combustion of coal-derived gases. Quarterly technical progress report, December 15, 1978-March 15, 1979.** Bracco, F.V.; Bruno, C.; Kim, B.; Santavicca, D.A.; Semler, J.H.; Walsh, P.M. (Princeton Univ., NJ (USA). Dept. of Mechanical and Aerospace Engineering). 1 Apr 1979. Contract EF-77-S-01-2762. 55p. Dep. NTIS, PC A04/MF A01.

A review was made of the available data on amounts of nitrogen-containing impurities present in coal-derived low and medium-Btu gases (Walsh, 1978). A brief summary of the available models for catalytic combustors is given in Section III of this report. An experimental investigation was made of carbon monoxide combustion in the presence of platinum supported on a monolithic Cordierite substrate. Axial profiles of substrate temperature, gas temperature, and stable species concentrations were measured at various inlet velocities and carbon monoxide concentrations. These data were presented in an earlier progress report and at the Third Workshop on Catalytic Combustion. Data on catalytic combustion of a medium-Btu gas are presented in Section III of this report. The computer code being developed to model catalytic combustion has been improved by addition of the species-dependent equation of state and temperature and pressure-dependent transport coefficients. Computed axial and radial gas temperature and carbon monoxide concentration profiles inside a catalyst channel during carbon monoxide combustion are presented. The integrated carbon monoxide concentration profiles at the exit are compared with the experimentally measured values. Summaries of the resonance absorption and Raman scattering techniques for measuring gas temperature and species concentrations are presented.

23427 (FE—3125-15) **Advanced development of a short-residencemtime hydrogasifier. Quarterly technical progress report, October 1, 1979-December 31, 1979.** Friedman, J. (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). Jan 1980. Contract ET-78-C-01-3125. 95p. NTIS, PC A05/MF A01.

Fifteen coal hydrogasification tests were conducted using the 6.07-in. ID, 15-ft-long reactor tube. The first five tests, which were conducted with oxygen fed directly into the reactor through the injector face, have shown that operation in this mode allows hydrogen-to-coal ratios as low as 0.2 at reactor exit temperature ~ 1800°F. However, it has also become evident that this mode of injection results in substantially lower CH_4/CO concentration ratios in the product gases than are experienced when the oxygen is reacted in a preburner. During the subsequent two tests, the injector was damaged at one of the oxygen orifices through the face because of a flaw in the fabrication of the orifice. A backup injector was mated to a reworked reactor tube, and eight more tests were successfully completed. The on-line gas chromatograph was activated and has been operating satisfactorily. There has been a continual improvement in the material balances, primarily because of improved material handling, weighing, and analytical techniques. Among all of the tests conducted to date, the conditions of Test 318-036 appear to be the most promising; the overall carbon and hydrogen balances for this test are in the range 95 to 105%, with carbon conversions to methane and benzene equal to 40.4% and 11.8%, respectively. The relative high conversion to benzene suggests that the conditions of this test might represent appropriate conditions for a commercial hydrogasification plant operating under the mode of benzene coproduction. Plans for experiments on the gasification of peat have been developed, peat materials acquired and arrangements made for drying and grinding. Preliminary gasification in tests have been carried out.

23428 (METC—8450-T1) **Coal processing for fuel cell utilization. Task XI. Fluidized bed coal gasification model; data analysis and predictions.** Finson, M.L. (Physical Sciences, Inc., Woburn, MA (USA)). Jan 1980. Contract EW-78-A-21-8450. 69p. (TR—209). NTIS, PC A04/MF A01.

This report describes development and application of a computational model for fluidized bed gasification of coal. A two phase bubbling bed reactor model accounts for the development of bubbles, clouds, and emulsion, with a new statistical treatment to predict bubble size. Coal char reactivity is described in detail, using models for carbon heterogeneous chemistry, pore struture, and mass transport previously developed at PSI. Volatile release is handled in a semi-empirical manner, and potential gas phase reactions between fuel and oxygen in the bubbles are allowed. The theory yields qualitatively correct trends in comparison to results from the U-GAS pilot plant. However, the data imply larger gas by-passing and particle carry-over than predicted, and the computed performance exceeds that observed. The computer program has been exercised to map out gasifier performance over a range of conditions. It is shown that proper fluidization often requires more gas flow than can be accommodated chemically, due to limited kinetics and mass transport. Increasing the bed temperature is beneficial, if not ruled out by coal caking and agglomeration tendencies. Increasing the pressure is not particularly advantageous, but major benefits in terms of off-gas heating value and gasifier efficiency can be obtained by reducing the coal feed size. Potential improvements to the theory are discussed.

23429 (SAN—1429-52) **Molten Salt Coal Gasification Process Development Unit. Quarterly technical progress report No. 13, April-June 1979.** Slater, M.H. (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). 30 Sep 1979. Contract EF-77-C-03-1429. 56p. NTIS, PC A04/MF A01.

This represents the thirteenth quarterly progress report on the Molten Salt Coal Gasification Process Development Unit (PDU) project. The project includes the design, construction, and operation of a PDU which will convert 1 ton of coal per hour into low-Btu gas. The third successful gasification run was performed. The solids feed system, the combustion air system, the gasifier/quench system, the ash removal system, the sulfur removal system, and the sodium carbonate regeneration system were all operated simultaneously as a single, integrated unit. The gasifier was operated at atmospheric pressure for a total of 272 continuous hours. Gas was produced with an average HHV of 88.6 Btu/scf while gasifying coal at a rate of 400 lb/hr.

23430 **Method for the gasification of carbonaceous matter by plasma arc pyrolysis.** Camacho, S.L. (to Technology Application Services). US Patent 4,181,504. 1 Jan 1980. Filed date 26 Aug 1977. 26p.

Apparatus and method for gasification of carbonaceous matter by plasma arc pyrolysis are disclosed. In one embodiment, a refractory-lined furnace is provided with a depression along its base for holding a pool of molten metal which acts as the external electrode for a bank of long arc column plasma torches which provide a heat mass for the process. The plasma arc pressure imparts momentum to the surface of the melt and causes it to flow in cusping eddy currents during the process. Crushed coal is deposited through the roof of the furnace by a rotary feeder in continuous plural streams. The coal is devolatilized in a matter of milli seconds, and

the volatiles are cracked as the coal falls by gravity through the interior of the furnace. The remaining carbon-rich char collects at plural sites on the surface of the melt, and the mounds of char are rotated by the eddy currents. Steam is continuously injected into the furnace to produce hydrocarbon gases through reaction with the carbon-rich char. A residence time of 5 to 30 min produces carbon utilization of up to 92%. The hot raw gases are directed through a gas cooler where heat is extracted for producing the process steam, and the cooled raw gases are upgraded to pipeline quality by conventional CO_2 and moisture removal techniques and by methanization with catalysts. The raw gas may also be burned directly as a medium-Btu gas or used as a reductant in the direct reduction of iron ore.

23431 Method for the direct reduction of iron using gas from coal. Meissner, D.C.; Sanzenbacher, C.W. (to Midrex Corp.). US Patent 4,173,465. 6 Nov 1979. Filed date 15 Aug 1978. 8p.

A method is described for direct reduction of iron in a shaft reduction furnace. Spent gas from the furnace is upgraded in reductant by removal of CO_2 and water to form an upgraded gas. A fossil fuel is gasified to produce a hot gas which is tempered with a first stream of upgraded gas. The mixture is desulfurized by reaction with lime to produce hot desulfurized gas. A second stream of upgraded gas is heated and mixed with the hot desulfurized gas to produce hot reducing gas. 6 claims.

23432 Coal gasification: the state of the art. Clark, E.L. pp 12-22 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

It would be improper to discuss the state of an art, such as coal gasification, without considering its potential for actual use. This is particularly critical for a process such as coal gasification where its development depends greatly on large-scale operation in a commercial atmosphere. It appears that major commercial construction of coal gasification plants will depend on industrial usage of coal-derived fuel gases. Government assistance through DOE funding does not seem to be a near-term prospect. (This may change as production of petroleum is decreased, for example in Iran.) This means that coal gasification must compete with other fuels on an economic basis. There is no question that gaseous fuel prices will increase in the coming years. Whether this increase will be of sufficient size within the 1980's to allow coal gasification to compete is not easily determined. It does appear from EPRI estimates that fuel gas could become competitive. A cost of $2 to $3 is projected for large plants using 10,000 tons of coal (at $1/million Btu) per day. These costs are in mid-1975 dollars. However, fuels synthesized from coal have an uncertain history of cost estimation. We should not neglect the effect of environmental changes on the use of coal gasification. The combustion of clean, coal-derived gases may be ideally suited to areas where further atmospheric deterioration is not desirable. This effect will provide an advantage for coal gasification as coal use increases.

23433 High-temperature Winkler coal gasification process. Franke, F.H. (Rheinische Braunkohlenwerke AG, Cologne, West Germany); Pattas, E.; Nitschke, E.; Keller, J. pp 86-96 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

In several countries intensive work is being performed on the further development of the coal gasification technology. These development projects have different aims, depending on the type of coal used, the intended application of the raw gas produced, and other special conditions. In all cases, however, the aim is a gasification process which fulfills the following requirements in particular: simple mode of operation, low trouble incidence and high degree of automation; high capacity per unit; generation of a raw gas which largely meets the conditions regarding composition without requiring subsequent expensive treatment steps; operation under pressure; high gasification rate, efficient utilization of the process heat and favorable consumption figures; and adaptability to various types of coal. One of the development projects in the Federal Republic of Germany is the high-temperature Winkler process (HTW). The project is subsidized by the Federal Ministry for Research and Technology. The object of this paper is to describe the state of development and the possibilities of application of this process.

23434 Treatment of waste water effluents from coal gasification units. Wyatt, J.M. pp 109-129 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

Removal of priority pollutants will be of concern to the coal gasification industry; however, relatively few data are available to determine any one particular control technology suitable for all gasification waste waters. Various methods of treatment, including reverse osmosis, activated carbon, chemical precipitation, and vapor compression distillation technology, have been advocated for processing waste waters to remove priority pollutants. Several conclusions have been noted for the applicability of these processes for utility waste waters: (1) Activated carbon may achieve residual levels on the order of 1 μg/l for many of the single-compound organics on the priority pollutant list. Multicompound removal by activated carbon is still not well known or easy to predict. (2) Activated carbon has limited promise for removal of the inorganic priority pollutant species, particularly heavy metals such as mercury, arsenic, and cadmium. (3) Reverse osmosis is generally very effective in removing organic compounds with molecular weights above 200 and is reasonably effective for removing inorganic priority pollutants. (4) No one chemical coagulation system gives the best removal for all pollutant forms. Table 18 gives a recommended coagulant dosage, optimum pH range, and minimum levels achievable for precipitation treatment of various heavy metals. (5) Vapor compression distillation cannot be economically justified in any area where water is in reasonably adequate supply. A considerable amount of information is needed before the appropriate control technology for effluent polishing to meet either reuse or strict limitations for priority pollutants can be selected for any particular coal gasification process.

23435 Carbon monoxide shift catalysts and carbonyl sulfide hydrolysis catalysts. Dybkjaer, I. (Haldor Topsoee A/S, Lyngby, Denmark). pp 133-139 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

Efficient conversion of the very high concentration of carbon monoxide to hydrogen and carbon dioxide by the shift process is essential for the economics of ammonia production from heavy oil or coal. Traditionally, the conversion is done with an iron-chromium catalyst. The activity of this catalyst in hydrogen sulfide containing gas is, however, rather poor, and a relatively high reaction temperature, in the order of 350°C (662°F) minimum, is required to obtain a reasonable reaction rate. In the TVA project, a new sulfur-tolerant shift process is incorporated. The process is based on the use of a highly active sulfur-tolerant shift catalyst, which was invented at the Exxon Research and Development Laboratories in Baton Rouge. The catalyst, which is designated SSK, was further developed for commercialization by Haldor Topsoee A/S in Denmark, which has a worldwide license to produce and market this new catalyst. The main features of SSK are the following: it has the unique property of being highly active for the reaction of carbon monoxide with steam in the presence of hydrogen sulfide, at temperatures down to about 200°C (392°F); it maintains its activity over a very wide range of operating conditions including temperatures up to 475°C (887°F); no specific catalyst poisons are known for SSK. It should especially be mentioned that it is insensitive to the presence of even relatively large amounts of chlorine in the process gas; a minimum concentration of hydrogen sulfide in the process gas is required to maintain the activity of SSK.

23436 Claus UCAP (integrated UCAP) sulfur recovery. Parnell, D.C. (Ford, Bacon and Davis Texas, Inc., Dallas). pp 154-156 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

One of the gaseous products from the coal gasification operation is hydrogen sulfide, a toxic and controlled substance. The most frequently used procedure for reducing atmospheric pollution caused by this toxic H_2S gas or its product of combustion (the more toxic SO_2 gas) is to convert the H_2S to elemental sulfur. The nontoxic elemental sulfur then can be successfully stored and shipped as a liquid or solid. The process used to recover elemental sulfur from H_2S is called the modified Claus process. The overall sulfur recovery from this process can vary from 75% to 97%, and is dependent on many variables. These include (1) number of reaction stages used, (2) H_2S composition of the feed gas, (3) sulfur condensation temperatures used, (4) presence of diluents such as CO_2 and H_2O in the feed gas, and (5) presence of other combustibles in the feed gas, such as hydrocarbons. The presence of both CO_2 and H_2O limit the maximum obtainable overall sulfur recovery. An alternative developed recently eliminates many of these problems caused by the high CO_2 content of the feed. This new process is called UCAP and was developed by Union Carbide. It uses the principle of total combustion of the acid gas, converting all the H_2S to SO_2. The resultant stream is cooled in a waste heat boiler, producing steam as a byproduct. The potential use visualized for the coal gasification application is to combine the SO_2 vapor stream with the H_2S stream in a single reactor Claus unit to recover the elemental sulfur. This combined operation, known as the integrated UCAP process, can recover about 99.9% of the feed sulfur as molten sulfur. Several advantages over the normal Claus plant are realized. Another procedure commonly used to maximize the sulfur recovery on a Claus unit is to treat the tail gas in a SCOT plant.

23437 Status of the Texaco coal dust gasification operating in the Ruhrchemie/Ruhrkohle demonstration plant at Oberhausen-Holten. Cornils, B. (Rhurchemie AG, Oberhausen, West Germany); Hibbel, J.; Langhoff, J.; Seipenbusch, J. pp 184-192 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

For various reasons traditional coal gasification processes do not meet current demands. The development and choice of modern coal gasification processes - aiming at supplying the chemical industry with syngas - should consider the following factors: Gasification should ensue under pressure in order to facilitate high space/time throughputs, thereby also reducing reactor volume requirements and presenting syngas at high pressure for subsequent process steps. Gasification should be at high reaction temperatures to avoid tar formation and suppress methane formation ensuring low gas purification costs. The possibility of utilizing a finely divided coal feedstock would be an attractive feature. The transport and introduction of finely divided coal as a suspension in a liquid would extend the application area of a gasification process. The use of water as suspension agent would eliminate the necessity of separately generating steam - the gasification agent. In addition, the plant would be a net supplier of steam. Modern gasification units should, therefore, facilitate the conversion of a finely divided coal, suspended and transported in liquids, at high temperatures and raised pressures. An agreement was reached with the owners of the technology - Texaco Development Corp. - that the know-how gained from the operation of the pilot plant at Montebello, California, was to be made available and the Texaco principle was to be transformed into a commercial-scale process in a demonstration plant. Operation and process optimization of the demonstration plant are described.

LIQUEFACTION

REFER ALSO TO CITATION(S) 23417, 23419, 23423, 23453, 23458, 23562, 24336

23438 (DOE/ET/14803—T4) **Coal liquefaction catalyst development. Quarterly progress report No. 3, October 1-December 31, 1979.** Kim, D.K.; Pellet, R.J.; Mahoney, J.A. (Amoco Oil Co., Naperville, IL (USA). Research and Development Dept.). Jan 1980. Contract AC01-79ET14803. 38p. Dep. NTIS, PC A03/MF A01.

Catalytic baseline runs continued with HDS-1442A in order to improve our baseline statistics as well as to monitor batch reactor performance. Testing of several new catalyst formulations was completed. No promising candidates for testing in the continuous aging unit were identified. The new SRC-II slurry oil was evaluated as a hydrogen donor liquefaction solvent. Our data indicates that the SRC-II heavy distillate oil is not as effective a hydrogen donor solvent as the hydrogenated anthracene oil. It is possible that the catalyst plays a key role in the thermal liquefaction reactions by improving the hydrogen donor properties of the slurry oil through in-situ hydrogenation. The differences in liquefaction behavior between Illinois No. 6 and Wyodak coal were determined. A major portion of our effort was concerned with ascertaining the liquefaction behavior of a Western coal such as Wyodak with AMOCAT type catalysts. A two-month program to determine the feasibility of using the Amoco continuous aging unit for SRC-I product upgrading was outlined.

23439 (EPRI-AF—1255) **Upgrading of coal liquids for use as power generation fuels. Final report, February 1978-June 1979.** Angevine, P.J.; Becker, M.; Callen, R.B.; Dabkowski, M.J.; Granchi, M.P.; Green, L.A.; Heck, R.H.; Simpson, C.A.; Shih, S.S.; Stein, T.R. (Mobil Research and Development Corp., Paulsboro, NJ (USA). Process Research and Technical Service Div.). Dec 1979. 247p. Dep. NTIS, PC A11/MF A01.

Residual coal liquids were hydroprocessed in a fixed bed unit to upgrade them to power generation fuels. A series of catalysts was evaluated for the desulfurization of short contact time (SCT) SRC. Low sulfur (0.4 wt %) boiler fuels were produced with hydrogen consumptions as low as 800 and 1200 scf/B from Indiana V regular SRC and W. Kentucky SCT SRC, respectively. Constant temperature aging runs were conducted with both regular and short contact time SRC. A kinetic aging model was developed to estimate process conditions and yields in either a fixed bed or ebullated bed reactor. Chemical characterization indicated that W. Kentucky SCT SRC molecules are significantly larger and more polar than those of Indiana V regular SRC. The high conversion of asphaltenes to less polar material does not appear necessary for SRC desulfurization. A structural comparison was made between SCT SRC recycle solvent and hydroprocess-generated solvent to assess the potential of process solvent in an integrated short contact time SRC/hydrotreating scheme. The alkali metals found in SRC distillate were determined not to be organically bound and are easily removed by water washing or distillation. A heating value correlation was developed from a wide range of raw and hydroprocessed coal liquids, based on elemental composition.

23440 (FE—1517-89) **Coal liquefaction test center. Annual report, January 1, 1978-December 31, 1978.** (Fluor Engineers and Constructors, Inc., Irvine, CA (USA)). Nov 1979. Contract EX-76-C-01-1517. 28p. NTIS, PC A03/MF A01.

This is the 1978 annual technical report on the work performed at the Cresap Test Facility, Cresap, West Virginia by Fluor Engineers and Constructors, Inc., and Liquefied Coal Development Corporation for the Department of Energy under Contract EX-76-C-01-1517. The report describes and summarizes the results of all work performed in operating the facility to conducting mechanical component testing during the 1978 calendar year.

23441 (FE—1517-90) **Coal liquefaction test center. Quarterly report, April 1, 1979-June 30, 1979.** (Fluor Engineers and Constructors, Inc., Irvine, CA (USA)). Dec 1979. Contract EX-76-C-01-1517. 43p. NTIS, PC A03/MF A01.

This is the 1979 second quarterly technical progress report on the work performed at the Cresap Test Facility, Cresap, West Virginia by Fluor Engineers and Constructors, Inc., and Liquefied Coal Development Corporation for the Department of Energy under Contract EX-76-C-01-1517. The report describes and summarizes all work performed during the period April 1 through June 30, 1979. The final operational runs of the plant and the initiation of the plant deactivation and preservation work are discussed.

23442 (FE—1517-91) **Coal liquefaction test center. Quarterly report, July 1, 1979-September 30, 1979.** (Fluor Engineers and Constructors, Inc., Irvine, CA (USA)). Nov 1979. Contract EX-76-C-01-1517. 55p. NTIS, PC A04/MF A01.

This is the 1979 third quarterly technical progress report on the work performed at the Cresap Test Facility, Cresap, West Virginia by Fluor Engineers and Constructors, Inc., and Liquefied Coal Development Corporation for the Department of Energy under Contract EX-76-C-01-1517. The report describes and summarizes all work performed during the period July 1 through September 30, 1979. This quarter, essentially all activity was devoted to plant decommissioning and preservation.

23443 (FE—1517-92) **Coal liquefaction test center. Annual report, January 1, 1979-September 30, 1979.** (Fluor Engineers and Constructors, Inc., Irvine, CA (USA)). Jan 1980. Contract EX-76-C-01-1517. 27p. NTIS, PC A03/MF A01.

This is the 1979 annual technical report on the work performed at the Cresap Test Facility, Cresap, West Virginia by Fluor Engineers and Constructors, Inc., and Liquefied Coal Development Corporation for the Department of Energy under Contract EX-76-C-01-1517. The report describes and summarizes the results of all work performed in operating the facility to conduct mechanical component testing during the 1979 calendar year. The report also describes the deactivation, cleanout, and preservation of the facility after the termination of operations in May, 1979.

23444 (FE—2006-17) **Applied research and evaluation of process concepts for liquefaction and gasification of western coals.** Wiser, W.H. (Utah Univ., Salt Lake City (USA). Dept. of Mining and Fuels Engineering). Mar 1980. Contract EX-76-C-01-2006. 12p. NTIS, PC A02/MF A01.

The experimental work on coal dissolution in hydrogen donor solvents has been completed. The data are being analyzed and interpretated to explain the major structural features of each high volatile bituminous coal examined. The findings are related to the heterogeneity, polymeric nature, aromaticity, aromatic cluster size and distribution of the clusters in the coal. The results are specific to the particular coal, but agree generally with the current understanding of coal structure. The findings are extensive and quantitative. They have provided valuable new information on liquefaction behavior. The effects of pressure, temperature and contact time on sulfur removal were determined at a constant hydrogen/oil feed ratio of 5000:1 std cc H_2/cc oil, one specific catalyst bed weight (equivalent stationary bed heights of about 5 in.) and one catalyst particle size (49 micron average diameter). Within the chosen operating range, the SRC II allowed smooth and stable operation of the fluid bed without any agglomeration of the catalyst particles. Some typical results are shown.

23445 (FE—2044-51) **Partial liquefaction of coal by direct hydrogenation. Quarterly progress report, October-December 1979.** Falk, A.Y. (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). 1980. Contract EX-76-C-01-2044. 38p. NTIS, PC A02/MF A01.

Fifteen additional reactor tests with an average duration of ~ 1 hour each were made in the 1 TPH process development unit (PDU). The water-cooled heat recovery quench unit was employed for all of these tests. A total of 36 tests has been made in the PDU since installation of the high-pressure product recovery system. Seventeen of these tests, ~ 15 hours' cumulative test duration, have been conducted since installation of the heat recovery quench unit. In general, operation of the PDU is progressing smoothly. No significant operational/hardware problems were encountered. Long-

duration (~ 1-hour) tests are now being conducted on a relatively routine basis. The new product recovery system and heat recovery quench unit appear to be functioning well and as designed. Analysis of results from the tests conducted employing the heat recovery quench unit indicates carbon conversion results that are consistent with the results of the previous testing. Tables summarizing the test conditions and carbon conversion results, product gas compositions, and liquids (heavy and light oils) properties are presented. Construction and checkout of the BTX recovery system were completed. Testing employing the heat recovery quench unit and work on the process and economic study were continued.

23446 (FE—2315-45) **Refining and upgrading of synfuels from coal and oil shales by advanced catalytic processes. Laboratory and Pilot Plant studies of the processing of SRC-I. Second interim report.** Sullivan, R.F.; Stangeland, B.E.; Chen, H.C.; Rudy, C.E. (Chevron Research Co., Richmond, CA (USA)). Nov 1979. Contract EX-76-C-01-2315. 80p. NTIS, PC A05/MF A01.

Solvent refined coal (SRC) from the SRC-I process is a high melting solid material that contains large amounts of nitrogen, oxygen, and metallic contaminants and is low in hydrogen content. It is a feed that is extremely difficult to convert to transportation fuels in high yields using commercial, fixed-bed, catalytic hydroprocessing technology. In this study, it was demonstrated that SRC-I can be hydrotreated in the presence of a coal-derived solvent at moderate cracking conversions (e.g., 50% conversion to material boiling below 850°F) for at least 1000 hours without serious plugging of the catalyst bed. However, even at these relatively low conversion levels, catalyst deactivation rates are unacceptably high. With higher severity hydroprocessing, high conversions can be obtained and most of the heteroatoms can be removed. However, severe plugging occurs in the catalyst beds in a short period of time. In subsequent studies to be described in future interim reports, we have shown that coal-derived liquids such as SRC-II and H-Coal process product are relatively attractive feeds for conversion to transportation fuels. We do not regard conversion of SRC-I to transportation fuels by the routes described here as being commercially feasible.

23447 (FE—2566-33) **Upgrading of coal liquids: hydrocracking of EDS process derived gas oils. Interim report.** Riedl, F.J.; deRosset, A.J. (UOP, Inc., Des Plaines, IL (USA). Corporate Research Center). Nov 1979. Contract EF-77-C-01-2566. 120p. NTIS, PC A06/MF A01.

The object of the work reported was to evaluate the applicability of commercial UOP catalysts and processes for hydrocracking coal-derived distillates produced by the Exxon Donor Solvent (EDS) process. Process conditions within commercial ranges were selected to produce either fuel oil or gasoline. Hydrocracking was done in two stages. When operating in the gasoline mode, the first stage produced a high nitrogen (~ 1000 ppM) product to be used in a series flow, two reactor, second stage hydrocracking process. When operating in the fuel oil mode, first stage operation produced a low (~ 10 ppM) nitrogen product to be used in a single reactor, second stage hydrocracking process. The volumetric yields of C_5^+ gasoline and butanes from the gasoline mode operation ranged from 105 to 115.5% and 18 to 26%, respectively. The octane number of the C_5^+ gasoline ranged from 75 to 83 RON clear. The overall hydrogen consumption ran from 3300 to 4200 SCF/bbl, all of which can be supplied by reforming the gasoline and steam reforming the C_1 to C_4 gases. In the fuel oil mode, yield of environmentally acceptable distillate was about 88%. Since the feed boils mostly in the fuel oil range to start with, this yield was obtained principally in the first stage. Fuel oil product quality was essentially unaffected by pressure. The overall hydrogen consumption was about 1650 SCF/bbl.

23448 (FE—2696-T4) **Development and application of analytical techniques to chemistry of donor solvent liquefaction. Quarterly progress report, March-May 1979.** Squires, A.M.; Dorn, H.C.; Taylor, L.T.; Dillard, J.G.; Rony, P.R. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Sep 1979. Contract EF-77-G-01-2696. 34p. NTIS, PC A02/MF A01.

A summary of work performed during the seventh quarter of Grant U 66023 is as follows: Major effort has concentrated on separation studies of small model compounds and selected fractions of coaly matter via gel permeation chromatography in tetrahydrofuran (THF), chloroform ($CHCl_3$) and pyridine solvents. Molecular weights have been determined for materials totally excluded and totally permeated in four soft gels which differ in percent crosslinking. A large number of compounds especially N-alkylated anilines exhibit a non-size exclusion mechanism of separation. Exclusion limits in pyridine appear to be considerably greater than in THF or $CHCl_3$ for n-alkanes. Results with these soft gels were compared with data obtained on rigid gels. Additional work is in hand regarding (1) the feasibility of nuclear magnetic resonance (NMR) for the liquid chromatographic detection, (2) functional group analysis via ^{19}F NMR of select coaly fractions and (3) liquefaction experiments in our micro-autoclave reactor.

23449 (FE—3137-T1) **Production of synthetic liquids from coal: 1980 to 2000. Preliminary study of potential impediments. Final report.** (Bechtel National, Inc., San Francisco, CA (USA)). Dec 1979. Contract ET-78-C-01-3137. 264p. Dep. NTIS, PC A12/MF A01.

It appears that resources will be adequate for the 1 MMBPD scenario. Potential impediments for the 3 MMBPD scenario were identified in the following areas: engineering manpower, manual labor, certain materials and equipment, and plant permits and licenses. The 3 MMBPD coal liquids scenario will tax the supply of chemical engineers for process and project work. Chemical engineers working in this area must be increased by one-third by 1985. Pipefitters, pipefitters-welders, boilermakers, boilermaker-welders and electricians will be in short supply. In certain regions of the country, 30 to 80 percent of the available manpower in some of these trades will be required by the 3 MMBPD coal liquids program. The availability of 34 categories of material and equipment was assessed in order to identify potential impediments. The following categories appear to be potentially critical for the 3 MMBPD program: draglines, heat exchangers, pressure vessels, centrifugal compressors, and alloy and stainless steel valves. The 3 MMBPD scenario would utilize about 3 percent of the national chromium consumption. Since almost all of the supply is imported, security of this supply could cause concern. It is the consensus of the major energy-related manufacturers that they can satisfy the requirements for the coal liquids program if sufficient lead-time is provided for material and equipment orders. Similarly, licensing and permits, water supplies, coal supplies and capital requirements will require careful planning and long lead-times for the 3 MMBPD scenario.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 23778, 23779, 23780, 23781

23450 **Synthesis of thermosetting polymers from the by-products of coal conversion processes.** Giori, C.; Eisenberg, W.; Yamauchi, T.; Shelfo, S.; Solomon, I. (IIT Research Inst., Chicago, IL). *J. Appl. Polym. Sci.;* **24**: No. 12, 2323-2332(15 Dec 1979).

The use of coal conversion by-products as raw materials in the synthesis of thermosetting polyesters has been investigated. Heavy tar residues were oxidized by gaseous oxygen in an alkaline medium, yielding a complex mixture of benzenecarboxylic acids and smaller amounts of aliphatic carboxylic acids. The mixture was polymerized by condensation with tetraethylene glycol bottoms, a byproduct of the synthesis of ethylene glycol. The resultant polyesters were cured by reacting them with epoxy resins in the presence of basic catalysts. Molded sheets and laminates were fabricated and tested. Tensile strength was found to increase with increasing curing time and with increasing concentration of epoxy crosslinking agent. Glass-reinforced composites fabricated by the autoclave process showed an increase in flexural and shear strength with decreasing autoclave pressure.

PROPERTIES

REFER ALSO TO CITATION(S) 23444, 23448, 23562, 24462

23451 (BMI—2053) **Thermophysical properties of coal liquids. Second quarterly technical status report, January 1-March 31, 1980.** Droege, J.W.; Stickford, G.H.; Chauhan, S.P. (Battelle Columbus Labs., OH (USA)). 15 Apr 1980. Contract AC01-79ET14941. 31p. Dep. NTIS, PC A03/MF A01.

The purpose of this program is to determine certain physical properties of coal-solvent slurries, namely, viscosity, thermal conductivity, density, heat of reaction, and specific heat, as these slurries undergo dissolution reactions. Major modifications to the viscometer were made, providing a lifting force more nearly constant with position of the bob, and a sensing coil for velocity measurements which gives a signal linear with velocity. Heating coils have been provided which allow faster heating and much better control. The viscometer has been calibrated with a series of liquids with a variety of viscous properties. The calibration constant varies somewhat with viscosity. A transient line source technique has been selected for thermal conductivity measurements. A thin vertical wire acts both as heater and thermometer. When a current is passed through the wire, its temperature changes in a manner that depends partly on the thermal conductivity of the surrounding medium. The actual measurement takes only a few seconds. Preliminary trials at room temperature have been encouraging. Calorimetric measurements have not yet begun. Density determinations may be possible as a byproduct of the viscosity work.

23452 (BNL—27607) **Study of coal oxidation by charged particle activation analysis.** Schlyer, D.J.; Wolf, A.P. (Brookhaven National

Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 9p. (CONF-800433—3). NTIS, PC A02/MF A01.

From 4. international conference on nuclear methods in environment and energy research; Columbia, MO, USA (14 Apr 1980).

It has been possible, using the technique of changed particle activation analysis, to follow the time course of the oxidation of coal exposed to air. The kinetics have been studied and seem to be consistent with a rapid initial uptake of oxygen containing molecules followed by slow diffusion into the surface of the coal particles. In this latter regard a study has been undertaken to study the depth profile of the oxygen into the coal particle surface. The depth of penetration of the activating particle is determined by the incident energy and therefore, by comparison to the appropriate standards, the depth profile may be determined either by varying the incident energy or by varying the particle size. Both approaches have been used and give consistent results. The depth to which a significant amount of oxygen penetrates varies from about 3 μm for very high rank coals to about 20 μm for low rank coals. This diffusion depth seems to be related to the porosity of the coals. A model for the low temperature air oxidation of coal has been developed to explain the resuts from the above mentioned experiments.

23453 (DOE/EV/2856—5) **Separation and structure elucidation of coal molecule fragments. Final report, February 1, 1976-August 31, 1979.** Schultz, R.V.; Jorgenson, J.W.; Maskarinec, M.P.; Kump, R.L.; Marli, F.; Novotny, M.; Todd, L.J. (Indiana Univ., Bloomington (USA). Dept. of Chemistry). Jan 1980. Contract EY-76-S-02-2856. 27p. Dep. NTIS, PC A03/MF A01.

Separation and identification of the polynuclear aromatic and aliphatic fractions of solvent-refined coal and its recycle oil were performed using a combination of solvent partition and chromatographic fractionation procedures with glass-capillary gas chromatography/mass spectrometry. Chromatographic profiles were generated for each fraction and some semiquantitative data were also obtained. In total, 146 polynuclear aromatic components of SRC were tentatively identified by their molecular weights, as indicated by the mass spectra of the gas chromatography peaks. In addition, wherever possible, specific isomers have been indicated, based on comparison of spectral characteristics and retention data. Separation and identification of nitrogen-containing aromatics of the recycle oil of SRC was accomplished with a combination solvent partition and capillary gas chromatography with deactivated glass columns. High-precision retention measurements of known pyridine and quinoline derivatives are reported, utilizing parent aza-arenes as retention standards. Both precisely measured retention data and mass spectral information combined lead to positive identification of some compounds in SRC samples. A total of 48 two-membered or three-membered aza-arenes have been tentatively identified in the recycle oil.

23454 (FE—2030-TR18) **Evaluation of an Automated Reflectance Microscope system for coal characterization. Technical report 18.** Liscinsky, D.S.; Vastola, F. (Pennsylvania State Univ., University Park (USA). Coal Research Section). Jan 1980. Contract EX-76-C-01-2030. 74p. NTIS, PC A04/MF A01.

The potential of an Automated Reflectance Microscope (ARM) system to determine the petrographic composition of a coal has been examined. The analysis involves the automatic scanning of a polished coal surface with a reflectance microscope. The reflectivity of consecutive 4-square-micrometer spots on the surface is measured by a photomultiplier tube and recorded by a microcomputer. This study was aimed at making the interpretation of a reflectogram more straightforward, that is, increasing the ability to discriminate among species. Although hardware improvements to decrease the spot size and the error associated with each reading would allow some increase in the ability to discriminate among species, the heterogeneous nature of the surface still limits the qualitative and quantitative information that can be derived from a reflectogram. Therefore a real-time data processing algorithm was implemented during data acquisition to study the effects that processing can have on a reflectogram. By measuring connectivity, it was found that edge readings could be indirectly eliminated. This greatly improved the ability to discriminate among species. Further investigation led to the conclusion that physical particle size has a major effect on a reflectogram. The concentration of coal in a pellet also has an effect on the ability to discriminate among species. A bonus of using processing to enhance the data was the ability to simultaneously gather information on particle size distributions. Based on the results the potential of an ARM system is improved by algorithm enhancement. The processing of the data allows some of the inherent limitations to be reduced.

23455 (FE—2030-TR20) **Effects of preoxidation on the swelling and softening of bituminous coals.** Maloney, D.J.; Jenkins, R.G.; Walker, P.L. Jr. (Pennsylvania State Univ., University Park (USA). Coal Research Section). Apr 1980. Contract EX-76-C-01-2030. 139p. NTIS, PC A07/MF A01.

A study was conducted to evaluate the applicability of a DuPont 942-TMA (Thermomechanical Analyzer) dilatometer system for the characterization of the swelling and softening properties of caking coals. The results of this investigation demonstrate the utility of this dilatometer system. Several parameters clearly defined with this unit are characteristic of the plastic transitions occurring upon carbonization. These include softening, dilation and resolidification temperature and volume contraction, expansion and total dilation values. The transition parameters measured with the 942-TMA unit are influenced significantly by coal particle size, dilatometer load, and heating rate. All transition temperatures exhibit marked increases with increasing heating rate. Softening temperatures decrease with increasing load and particle size. Dilation temperatures are essentially independent of dilatometer load effects and resolidification temperatures are independent of load and particle size over the range of conditions used in this study. Volume contraction and expansion values show an increase with decreasing coal particle size. Volume expansion values also exhibit strong heating rate and load dependencies. The results point up the great difficulty involved in obtaining truly fresh unoxidized coal samples. Storage of fine coal particles for extended periods of time in atmospheres with even slight oxygen concentrations show signs of weathering. Exposure of an HVA coal to dry air at ambient temperature has much less effect on subsequent swelling and softening properties than does exposure to moist air.

23456 (FE—2030-TR21) **Inorganic constituents in American lignites.** Morgan, M.E.; Jenkins, R.G.; Walker, P.L. (Pennsylvania State Univ., University Park (USA). Coal Research Section). Apr 1980. Contract EX-76-C-01-2030. 91p. NTIS, PC A05/MF A01.

Both the discrete mineral phases and the ion-exchangeable inorganic components of lignites from Texas, North Dakota, and Montana have been studied. The ion-exchangeable cations and the carboxyl groups with which they are associated were characterized by ion exchange methods utilizing ammonium acetate and barium acetate, respectively. Na, K, Mg, Ca, Sr, and Ba were found to be present in all three coals. It was found that Ca and Mg were the most abundant cations and that 40 to 60% of the carboxyl groups in the raw coals were exchanged with cations. Also, significant variations in the relative and absolute concentrations of all the cations were observed. The discrete mineral phases in these lignites were studied by semiquantitative x-ray diffraction and infrared spectroscopy. The importance of the cations in this analysis was shown when the mineralogical analyses of the low temperature ash of the coals with the cations removed and the raw coals were compared. Results show that up to 50% of the low temperature ash of these raw coals can be attributed to the existence of metal cations and that fixation of sulfur, carbon, and oxygen to form sulfates and carbonates is the major reason for this contribution.

23457 (METC/SP—79/10(Pt.1), pp 460-470) **Determination of ^{226}Ra, ^{214}Pb, and ^{214}Bi in fly ash samples from eighteen (18) coal fired power plants in the United States.** Morris, J.S. (Univ. of Missouri, Columbia); Bobrowski, G. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Since the collected ash residue (fly ash) from coal fired power plants could potentially be classified as a hazardous waste it was decided that these materials and related ones would be studied; The objectives of this work were: (1) to analyze representative fly ash samples from various power plants for ^{226}Ra; (2) determine difference, if any in ^{226}Ra activity attributable to whether the coal came from the eastern or western part of the United States; and (3) determine the relationship of the ^{226}Ra to its daughters, ^{214}Pb and ^{214}Bi for the purpose of assessing loss of ^{222}Rn. This study has demonstrated that: (1)^{226}Ra, ^{214}Pb, and ^{214}Bi can be measured reasonably well at the 1 to 10 PCi/g range in fly ash and related samples by a completely instrumental approach involving gamma counting; (2) that, based on ^{214}Pb and ^{214}Bi activity measurements, secular equilibrium appears to exist in fly ash samples; (3) that, loss of ^{222}Rn from an unbound fly ash, while varying considerably, averages ~ 40%. This points to a need to study ^{222}Rn losses when fly ash is bound with cement in construction materials; and (4) that, fly ash samples from western coals were unexpectedly lower in ^{226}Ra, ^{214}Pb, and ^{214}Bi activity than analogous samples from eastern coals. It would appear that legislation regulating the ^{226}Ra content in fly ash amended building materials should be the result of careful studies such as the ones the EPA suggest as well as comparative studies which consider all aspects of recycling coal residues (such as the use of fly ash in the construction industry) as opposed to attempt to store or dispose of these residues.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 23413, 23516, 23517, 23542, 24031, 24035, 24311, 24312, 24313, 24316, 24318, 24461, 24462

23458 (DOE/PC/20023—1) **Environmentally acceptable disposal of coal conversion solid waste residuals. Progress report, April 21, 1979-July 31, 1979.** Neufeld, R.D. (Pittsburgh Univ., PA (USA). Dept. of Civil Engineering). 1 Aug 1979. Contract AC22-79PC20023. 10p. Dep. NTIS, PC A02/MF A01.

Laboratory and report preparation activities are underway to investigate basic phenomena that would assist demonstration and commercial sized coal conversion facilities in the environmentally acceptable disposal of process solid waste residuals. Laboratory columnar and rapid leaching evaluations are being conducted in accord with RCRA guidelines and other techniques. Preparations are being made for Ames Testing of derived leachates.

23459 (FE—3269-11A) **Design, construction, operation and evaluation of a prototype culm combustion boiler/heater unit: site evaluation and socio-economic impact.** (Stone and Webster Engineering Corp., New York (USA)). Jun 1979. Contract ET-78-C-01-3269. 195p. (CW-WR—78-036-11A). NTIS, PC A09/MF A01.

An attractive feature of fluidized bed combustion is the ability to control SO_2 emissions by employing a sulfur sorbent bed material such as limestone, thus eliminating the need for flue gas desulfurization. Emissions of SO_2 from the proposed facility will be controlled to levels well below state standards by the addition of appropriate quantities of limestone to provide 88% SO_2 collection efficiency. Another important environmental aspect of fluidized bed combustion regarding air quality is the relativey low levels of NO/sub x/ emissions. The relativey low combustion zone temperature of approximately 1550°F in the fluidized bed results in less formation of NO/sub x/ than in conventional boilers. The proposed facility will control NO/sub x/ emissions to below 0.32 lb/mm Btu. Particulate emissions will be controlled to levels below state standards by employing a primary cyclone for carbon reinjection secondary cyclones for particulate removal prior to the air preheater and a fabric filter for final flue gas cleaning. The control measures outlined above, in addition to a stack height of 125 ft, will result in minimal impacts on ambient air quality in the Shamokin area.

23460 (METC/SP—79/10(Pt.1)) **Fifth international ash utilization symposium.** Faber, J.H.; Babcock, A.W. (comps.). (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). 1979. 476p. (CONF-790205—(Pt.1)). Dep. NTIS, PC A21/MF A01.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The Fifth International Ash Utilization Symposium was sponsored by the National Coal Association, American Public Power Association, US Department of Energy, National Ash Association, US Environmental Protection Agency, and the Edison Electric Institute. It was held at Atlanta, Georgia, February 25-27, 1979. Twenty-seven papers from the proceedings have been entered individually into EDB and ERA. The papers deal with the characterization of fly ash, ashes, slags and sludges and their possible uses or methods of waste disposal. (LTN)

23461 (METC/SP—79/10(Pt.1), pp 29-33) **CEGB overview.** Dent, J.K.; Knight, P.G.K. (Central Electricity Generating Board, London, England). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

This paper describes the present situation of ash utilization in England and Wales, the area served by the Central Electricity Generating Board. A survey of existing and prospective markets is followed by a discussion of marketing techniques appropriate to the Board's circumstances. In conclusion the impact of UK legislation on health and safety at work is reviewed.

23462 (METC/SP—79/10(Pt.1), pp 34-38) **Responsibility for quality control and quality assurance of fly ash.** Hyland, E.J. (American Admixtures Corp., Chicago, IL). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Fly ash lacking quality control suitable for sale as a raw material to sophisticated industries such as cement, but potentially disasterous if sold to end-users such as concrete producers who lack the ability to analyze for quality. Electric utilities must either equip themselves with staff and laboratory to provide QA/QC or select a competent marketing company if the sale of fly ash to end-users is contemplated. Marketing companies must not be selected only on the basis of fly ash revenue to the utility, but primarily on their ability to represent the utility ethically, devclop and maintain markets, insulate the utility from product liability, and train customers in proper use of fly ash.

23463 (METC/SP—79/10(Pt.1), pp 45-50) **Impact of proposed RCRA regulations on resource recovery and utilization.** Kinder, D.L. (American Electric Power Service Corp., Charleston, WV). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Utility by-products being reused today appear to pose no threat to human health and the environment; however, if, ultimately, power plant ash should be declared hazardous, EPA's proposed regulations would force regulation of these by-products. Under RCRA, Congress' intent was to regulate discarded materials and not reusable materials. EPA's present regulatory approach would bring most reuses under the Subtitle C regulations. The regulatory cost and burden would discourage or terminate most reuses. The ash producers and users have until March 16, 1979 to comment on the proposed regulations. The story on ash utilization that is being told here in Atlanta during this symposium should be delivered to Washington. In order to accomplish this objective, the electric utility industry is working with the National Ash Association and the Utility Solid Waste Activities Group (USWAG) to formulate comments to be submitted to EPA. We strongly urge you to assist these groups in any way possible by supplying information on reuse applications utilizing power plant ash, and also to consider making your individual views known to EPA.

23464 (METC/SP—79/10(Pt.1), pp 51-55) **Government procurement of recycled products: fly ash in cement and concrete.** Hansen, P.; Heffelfinger, J.M. (Environmental Protection Agency, Washington, DC). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The Resource Conservation and Recovery Act has two major objectives: (1) the protection of human health and the environment, and (2) the conservation of valuable material and energy resources. Section 6002, Federal Procurement, has one basic mandate - procuring agencies must purchase items containing the maximum practicable amount of recovered materials. However, this must be done in keeping with what we refer to as the four reasonables. That is, recycled products must be technically equivalent or reasonably so as relates to performance. The recovered material product must be available at a reasonable price, as compared to the typically virgin product which is normally purchased. Reasonable competition must be maintained. Finally, the product must be available in terms of delivery time and geographic locations. I believe that fly ash, when used either in blended cement or as an admixture in concrete, can meet all of these reasonables. Soon after EPA undertook this effort, it became clear that this information could not be developed for all 50,000 Federal specifications and standards. We decided to concentrate only on those items which demonstrated the highest potential for resources recovery through Federal procurement. Criteria were developed to aid in that selection process. These criteria are: (1) the waste material must constitute a significant part of the solid waste stream; (2) economic methods of separation and recovery must exist; (3) the material must have technically proven uses; and (4) Federal purchasing power for the final product must be of sufficient size. EPA has chosen four major product guidelines under Section 6002 - paper products, construction products, fly ash in cement and concrete, and composted sewage sludge.

23465 (METC/SP—79/10(Pt.1), pp 56-67) **Engineering analysis and comparison of new processes for the recovery of resource materials from coal ash.** Canon, R.M.; Seeley, F.G.; Watson, J.S. (Oak Ridge National Lab., TN). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

During the past 2 years, several promising new processes for the recovery of valuable resource materials from coal ash, primarily power plant fly ash, have been conceived and investigated at the Oak Ridge National Laboratory. These processes, which include direct acid leach, the salt-soda sinter process, and the Calsinter ($CaSO_4$-$CaCO_3$) process, are designed to remove the major metals (aluminum, iron, and titanium) from fly ash; however, some are also capable of recovering trace metals. The sintering processes are particularly efficient in metal recovery and perhaps can produce nonhazardous solid wastes, as defined by the Resource Conservation and Recovery Act. The salt-soda sinter process can recover 95% of the aluminum and 90% of the iron and titanium while producing a solid containing mostly silicates similar to silica gel. The Calsinter process recovers approximately the same amounts of the metals and produces solids similar to plaster of paris. This process is particularly attractive because it can consume large amounts of flue-gas desulfurization (FGD) sludge as well as fly ash. Engineering and preliminary cost analyses have been prepared for these processes (and the lime-soda sinter process) for a plant consuming one million tons of fly ash (dry basis) per year. A comparison of strengths and weaknesses of the various processes is presented.

23466 (METC/SP—79/10(Pt.1), pp 68-84) **New developments in the lime-soda sinter process for recovery of alumina from fly ash.** Murtha, M.J.; Burnet, G. (Ames Lab., IA). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

A further investigation of the lime-soda sinter process has resulted in unique correlations between sinter composition and yield of alumina for fly ashes from both bituminous and subbituminous

coals. Either an excess or deficiency of limestone or soda ash compared to the quantities called for by the correlations will reduce the recovery of alumina below the better than 90% level otherwise attainable. No apparent difference in reactivity was found between the calcium contained in the fly ashes and that in the added limestone. Lower sintering temperatures can be used for fly ashes from subbituminous coals. Process economics are determined largely by the alumina and calcium contents of the ash, the sintering temperature required, and sales credit for by-products.

23467 (METC/SP—79/10(Pt.1), pp 85-89) **Role of flyash brick manufacturing in energy conservation.** Slonaker, J.F. (West Virginia Univ., Morgantown). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Flyash brick, developed by the Coal Research Bureau at West Virginia University, have several characteristics which should enable them to be manufactured with the expenditure of from 20 percent to 50 percent less energy than clay brick. This paper discusses the areas in which energy savings can be realized by manufacturing flyash brick instead of clay brick. Several factors contribute to the energy savings, but perhaps the largest factor is that flyash has undergone considerable heat work in the electric utility boiler and is a pre-fired material. Little additional heat work is required to form the ceramic bonds necessary to produce a superior quality brick.

23468 (METC/SP—79/10(Pt.1), pp 90-133) **Fly ash for use in the industrial extender market.** Hurst, V.J. (Univ. of Georgia, Athens); Styron, R.W. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

A basic review of fly ash reveals the nature of the material through fine particle technology utilizing bulk chemistry, mineralogy and microscopy. Individual grain studies indicate potential for industrial extenders and enhanced pozzolan. Carbon may be removed in commercial value and sold as filler for rubber goods and as an activated carbon. Cenospheres may be removed and sold as selected fillers. An iron-rich fraction may be removed and sold to various markets. Pilot studies reveal that current commercial technology can be utilized to remove the various products for sale to filler markets. Market studies indicate a 10 million ton, 900 million dollar market for industrial extenders in the United States. Engineering studies, although preliminary, indicate that fly ash can be processed into industrial extenders and enhanced pozzolan on a profitable basis.

23469 (METC/SP—79/10(Pt.1), pp 134-139) **Australian cenospheres.** Ashby, J.B.; Carroll, J. (B.M.I. Ltd., Sydney, Australia). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The main use of Australian cenospheres is in plastics. Cenospheres are suitable for this application because they are light in weight, strong and have a low resin demand. On this last point, comparing equal bulk volumes of the two, cenospheres have been found to require less resin per volume of product than talc. Fiberglass panel made using cenospheres has good qualities in that it can be drilled, sanded and sawn, as well as being low in shrinkage. Utilization of cenospheres in Australia is still in its infancy as the material has only been generated over the last few years. Recent developments indicate that Australia will approach 100% utilization of this exotic material as a filler in epoxy resin applications.

23470 (METC/SP—79/10(Pt.1), pp 165-192) **Recovery of resource materials from coal ash.** Seeley, F.G.; Canon, R.M.; McDowell, W.J. (Oak Ridge National Lab., TN). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Laboratory-scale tests of methods for the recovery of aluminum and other metal values from fly ash include reported processes such as lime sinter, lime-soda sinter, and the obvious direct acid leach methods, as well as two new combination sinter-dilute acid leach methods. In the first of these new methods, fly ash is sintered with a $NaCl$-Na_2CO_3 mixture at 800°C followed by successive leaches with water and 1 N HNO_3 or H_2SO_4. In the second method, fly ash is sintered with a $CaSO_4$-$CaCO_3$ mixture at 1200°C, after which the sinter-cake is pugged with 36 N H_2SO_4 and then diluted to 4 N for a second leaching period. Aluminum recovery is increased in each method as the sintering temperature is increased; recovery is greater than 95% at the optimum sintering conditions, and a pure Al_2O_3 product can be obtained if a solvent extraction or an ion exchange circuit is included for iron and trace-metal removal. Product option flexibility is provided i that Fe, Ti, Mn, U, and Th can also be recovered.

23471 (METC/SP—79/10(Pt.1), pp 193-204) **Fly ash housing scheme: an experimental project in Neyveli.** Shanmugasundaram, M. (Neyveli Lignite Corp., South India). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

To demonstrate the potentialities of lignite fly ash in building construction, Neyveli Lignite Corporation engineers have formulated and completed an Experimental Low-Cost Fly Ash Housing Scheme for 20 houses, with accent on fly ash use. The design has been based on the principle of achieving economy without in any way sacrificing quality, durability, safety or strength, and by adopting labor intensive techniques which could make effective use of the abundant and economical labor and skill available locally. It has been so conceived as to contain fly ash omnipresent in almost all its components, thereby justifying its name as All Fly Ash House. These experimental fly ash houses, with fly ash omnipresent in most of its components and consisting of several new materials, new techniques, fresh concepts, and novel features, and with the accent on fly ash utilization, projecting the versatility of fly ash as a construction material leading to the double objectives of economy and technological benefits, has all the potentialities of being a trailblazer and a forerunner to civil engineers and the public in India of what could be achieved with ingenuity to turn a waste product (which could easily turn into an environmental pollutant) into a versatile and useful construction material and leading to construction economy and also substantially saving scarce and vital construction materials like cement, steel, and teakwood. Large scale utilization of fly ash in construction projects would incidentally reduce fly ash disposal costs, minimize pollution factors, and improve aspects and the ecological environs around thermal power projects.

23472 (METC/SP—79/10(Pt.1), pp 245-253) **Bottom ash lightweight aggregate.** Styron, R.W. (AMAX Resource Recovery Systems, Inc., Smyrna, GA). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

This paper takes an in-depth look at the history and production of bottom ash as a lightweight aggregate in the United States. The production and use of cinders as a lightweight aggregate has had poor results, but bottom ash from dry bottom boilers has been produced, processed, and successfully used as a lightweight aggregate in the southeastern United States.

23473 (METC/SP—79/10(Pt.1), pp 254-273) **Fly ash ponds.** Lechnick, W. (NUS Corp., Dunedin, FL); Lin, A.L.; Humphrey, H.J.; Dzurinko, E. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

A method has been developed to determine the retention time of water-ash sluice mixtures discharged to an ash pond. Results of field tests performed on a rectangular pond indicate that tracer compounds discharged with ash-sluice mixtures can move through an ash pond at velocities on the order of 20 feet per minute. This flow velocity is reduced by a factor of 10 to 20 where a barrier exists between the influent and effluent flow.

23474 (METC/SP—79/10(Pt.1), pp 274-293) **Field retention time studies of ash settling ponds.** Dzurinko, E.P.; Lin, A. (American Electric Power Service Corp., Dunedin, FL). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The installation of high efficiency electrostatic precipitators on coal fired power generating units results in the collection of very fine sized fly ash particles which do not settle as readily as larger and denser fly ash particles. In order to meet stricter NPDES discharge limitations, ash ponds must operate as efficient settling basins. Most existing ash ponds have been installed without the consideration of settling basin design criteria. Therefore, information on both the hydraulic characteristics of existing ponds and the settling characteristics of collected ash particles is needed for developing an overall modification plan to improve removal efficiencies of the existing ponds. A testing procedure to determine the liquid retention time of existing ponds has been field implemented.

23475 (METC/SP—79/10(Pt.1), pp 294-311) **Mechanical strength development and permeability of fly ash-sludge-lime mixtures.** Schwitzgebel, K.; Jones, B.F. Jr. (Radian Corp., Austin, TX). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Fly ashes from the major US coal basins were collected and analyzed. Ashes with a wide concentration range of pozzolanic components were subjected to further studies (CaO:1 to 31%; SiO_2:25 to 64%; Al_2O_3:11 to 28%; Fe_2O_3:4 to 19%:SO_3:0.2 to 7%; Na_2O + K_2O:1.4 to 4.7%). The mechanical strength development for fly ash-scrubber sludge-lime mixtures was followed as function of curing time. Strength development ranged from 0 to 5000 psi. The factors influencing the strength development most were the concentration of reactive calcium in the fly ash, the ash to sludge ratio, and the beneficiation through lime addition. The permeability of the test cylinders decreased exponentially with increasing strength development. It ranged from 10^{-4} to 10^{-10} cm/sec. Crystalline phases in the ashes and the cured cylinders were determined by x-ray diffraction.

Ettringite was positively identified in cured cylinders. Microprobe analysis of small crystallites and fibers connecting fly ash spheres revealed different Ca:Al:Si:S ratios. This technique shows promise as a method of identifying amorphous compound development as a function of curing time.

23476 (METC/SP—79/10(Pt.1), pp 312-327) **Largest use of fly ash-scrubber sludge disposal.** Smith, C.L. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

By 1982 a physico-chemical process for the environmentally safe landfill disposal of sulfur dioxide scrubbers sludges will be utilizing 2.5 million tons of fly ash annually. This, which will be the largest single usage of fly ash, is not an ivory tower idea. Firm commitments have been made for eleven utility-located processing plants in six states; four of these plants are already operative, utilizing over 900,000 tons of fly ash annually. The Poz-O-Tec process uses the synergistic effect of fly ash, SO_2 scrubber sludges of highly varying chemical nature and a lime-based additive to produce chemical reactions generating physically and chemically environmentally safe landfill material. At this time there are no other economically feasible disposal processes yielding equivalent environmental characteristics.

23477 (METC/SP—79/10(Pt.1), pp 328-343) **By-product-utilization/ultimate-disposal of gas cleaning wastes from coal-fired power generation.** Ellison, W. (NUS Corp., Rockville, MD); Shapiro, E. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

A review is given of pollution control rules in solids disposal called for by Public Law 94-580, The Resource Conservation and Recovery Act of 1976, and now formally proposed by EPA. The text of these requirements indicates that the disposal of solid collected and formed in cleaning of flue gas from coal-fired boilers can be expected to be subject to comprehensive environmental regulations governing design, permitting and operation of storage and disposal sites. Levels of concentration of heavy trace elements in fired coal will directly influence hazardousness in disposal of both fly ash and scrubber sludge, as well as the complexity of controls required for groundwater protection. A review of recently published details of EPA stir-testing procedures and toxicity data on mixtures of wet-collected fly ash and scrubber sludge indicates that fly ash and SO_2 solids may be expected to regularly test out as non-hazardous. At the same time, isolated disposal and broad availability of current and future fly ash production for by-product utilization may be significantly limited. This is the result of anticipated increasing use of dry fly ash catch as a fixation reagent to stabilize SO_2 sludge for improved ultimate disposal. Major site-related hydrological and geological factors affecting selection, design and operation of sites for permanent disposal of raw and stabilized solid wastes are reviewed along with techniques for preliminary investigation of acceptability of existing facilities and available sites. Utilization of fly ash and pyrites wastes in flue gas desulfurization (FGD), and emerging of commercial design technology for broadened application of coal-based regenerative FGD technology is described along with interrelated progress in management of coal cleaning waste.

23478 (METC/SP—79/10(Pt.1), pp 344-356) **Role of fly ash in structural types of stabilized applications.** Minnick, L.J. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

For many years fly ash has served as a basic ingredient in the preparation of compositions that can be used in applications such as road base, embankments, berms, dikes, liners, structural landfill, etc. These compositions are designed to meet a variety of specifications which relate specifically to the types of materials employed and the applications intended. The fly ash is normally blended with other materials, such as soil, bottom ash, slag, and gypsum, as well as conventional aggregates. In addition, other binders are frequently incorporated in the mix to develop a suitable matrix. These include asphalt, SO/sub x/ scrubber sludge, fluidized bed residue, portland cement, waste stack dust, and blast furnace slag. The paper presents a review of these applications and identifies the chemical and physical properties of the fly ash as it relates to these various mixtures. A brief review of some of the performance properties of the compositions is given and selected examples of projects are described to illustrate the type of results that have been obtained in a number of field utilization programs.

23479 (METC/SP—79/10(Pt.1), pp 357-404) **Evaluation of ash storage sites: a case history.** Delwiche, P. (Dairyland Power Cooperative, LaCrosse, WI); DiGioia, A.M. Jr.; Niece, J.E. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The economic and environmental analysis of alternative sites for conventional ash storage operations at Alma Generating Station has yielded the following results: (1) Wet storage represents the least monetary cost and the greatest environmental degradation; (2) Dry storage represents the greatest economic cost and generally least environmental degradation, depending upon site location; (3) Site 4 represents the least monetary cost alternative; (4) Site 1 represents the best dry disposal alternative; (5) Site 3 represents the second best wet or dry disposal alternative; (6) If Unit 6 fly ash is unsuitable for sluicing, it can be transported to wet storage sites in dry form, and then ponded. Otherwise, Unit 6 fly ash will require placement in a dry storage area on Site 1 by modified methods. Fly ash from Units 1 through 5 can be sluiced independently of Unit 6 fly ash; and (7) A highly reactive ash will increase the costs of all site alternatives and will make Site 1 dry and Site 3 wet essentially equal cost alternatives.

23480 (METC/SP—79/10(Pt.1), pp 405-447) **Characterization of flue gas cleaning (FGC) wastes from coal combustion.** Santhanam, C.J. (Arthur D. Little, Inc., Cambridge, MA); Ullrich, C.R. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The objective of this paper is to present a state-of-the-art review of the physical and chemical properties of coal ash and flue gas desulfurization waste. Together, these two comprise flue gas cleaning wastes. This paper is based on available information in studies sponsored by the US Environmental Protection Agency (EPA), Electric Power Research Institute (EPRI) and others.

23481 (METC/SP—79/10(Pt.1), pp 448-459) **Economic and environmental aspects of a new coal ash recycling/disposal process.** Pound, J. (American Admixtures Corp., Chicago, IL). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The purpose of this presentation is to share some of our insights into the opportunities and problems associated with ash recycling and disposal, created and measured by environmental standards, from the eyes of a fly ash marketing person, better known as a soot salesman. The general theme of this paper is how to plan and design for those problems and opportunities that go with utilizing recycling methods in addition to conventional disposal processes. This presentation is directed to power plant people who are confronted with the necessity of collecting, recycling and/or disposing of both fly ash and bottom ash. We will try to put you into our shoes as we see the present situation, at the same time keeping a careful eye on the environmental effects, the RCRA impacts and the various contract options available.

23482 (METC/SP—79/10(Pt.2)) **Fifth international ash utilization symposium.** Faber, J.H.; Babcock, A.W. (comps.). (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). 1979. 486p. (CONF-790205—(Pt.2)). Dep. NTIS, PC A21/MF A01.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The Fifth International Ash Utilization Symposium was sponsored by the National Coal Association, American Public Power Association, US Department of Energy, National Ash Association, US Environmental Protection Agency and the Edison Electric Institute. It was held at Atlanta, Georgia, February 25 to 27, 1979. Thirty-eight papers from Part 2 of the proceedings have been entered individually into ERA and EDB. The papers in Part 2 deal mainly with the use of fly ash in cements, concretes and grout; the use or waste disposal in roads, embankments and backfilling underground mines; and, in a few cases for the neutralization of acid mine drainage or the conditioning of soils. Several papers deal with the chemical composition of fly ash, with its physical and chemical properties and their variability. (LTN)

23483 (METC/SP—79/10(Pt.2), pp 471-481) **Estimating the leaching potential of coal combustion by-products.** Webster, W.C.; Gulledge, W.P. (Engineering-Science, McLean, VA). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Leaching from coal combustion by-products is a matter of concern. Test procedures have been developed for use in estimating the potential environmental hazard, but technical questions regarding the procedures are unresolved and the procedures appear to have a poor level of precision. Information is not available on the relationship of test results to field leaching characteristics, making realistic environmental interpretation of the results extremely difficult. Some by-products are expected to be declared hazardous under the proposed RCRA, Section 3001 classification system. The impact number of coal combustion by-products that will be declared hazardous (based on presently proposed and anticipated regulations) is uncertain due primarily to the following factors: (1) little or no data is available on the current EPA leaching method; and (2) the test procedures and limits ultimately selected for inclusion in the regulation will have a significant impact. Proper interpretation of data from any leach test procedure requires correlation of the test procedure with expected field leaching characteristics. No work has been completed in this area.

23484 (METC/SP—79/10(Pt.2), pp 482-495) **Specifications on fly ash for use in concrete: where we are - where should we go.** Mielenz, R.C. (Martin Marietta Corp., Cleveland, OH). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The present portland cement shortage in the United States has created an impetus for the increased use of fly ash as a partial replacement for cement. Consequently, there is concern for availability of fly ashes meeting one or more of the specifications pertaining to fly ash for use in concrete. For many years ASTM has been actively involved in updating the C-618 specification for fly ash and raw or calcined natural pozzolans for use as a mineral admixture in portland cement concrete. Fly ash offers large opportunities as a means to reduce energy content, reduce cost, and improve the quality of portland cement concrete. Its proper use decreases the need for portland cements other than Type I, such as Types II, IV, and V. However, these needs can be met only by increased breadth of performance standards on quality and variability than can be completed in minimum time. Standards for frequency of testing should be related to established variability of fly ash ash from specific sources.

23485 (METC/SP—79/10(Pt.2), pp 496-507) **Laboratory study of the effects of SO_3 and autoclave expansion of fly ash on concrete expansion and compressive strength.** Bobrowski, G.S.; Pistilli, M.F. (American Admixtures Corp., Chicago, IL). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

A study of the effects of SO_3 content and autoclave expansion of thirteen fly ashes ranging up to 9.62% SO_3 and 8.40% autoclave expansion on concrete properties was carried out. Concrete specimens have been stored in lime water for a year and no deleterious effects on strength or excessive expansion have been observed. The usefulness of current ASTM C-618 limits of these variables is called into question based on these results.

23486 (METC/SP—79/10(Pt.2), pp 508-521) **Characteristics of Australian flyash concrete.** Ashby, J.B. (Pozzolanic, Sydney, Australia); Ryan, W.G.; Munn, R.L. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The utilization of flyash in Australia depends mainly on its use in concrete. This paper deals with the characteristics of concrete containing flyash and indicates that by testing of the various properties of the concrete, specifying authorities and users have been assured that flyash concrete has much to offer the building industry. The characteristics investigated include compressive, flexural and tensile strength, drying shrinkage, creep, heat of hydration, durability and alkali-aggregate reaction. It is certain that without the developmental work that has gone into the use of flyash in concrete, the level of utilization of flyash in Australia would not be as high as it is. Some 13% of the flyash produced by bituminous and subbituminous coal burning power stations in Australia is effectively utilized. The major proportion of this use is in portland cement concrete. Fifteen years of use in commercially produced concrete has proved the acceptable characteristics of Australian flyash concrete.

23487 (METC/SP—79/10(Pt.2), pp 544-563) **Accelerated sulfate testing of mortars containing fly ash as a partial replacement for portland cement.** Pavlovich, R.D.; Rosner, J.C. (Engineers Testing Labs., Inc., Phoenix, AZ). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

This paper is concerned with an experiment to consider the comparative sulfate resistance of mortars made with fly ashes from two particular power plant sources. A secondary objective is to point up some of the difficulties in sulfate resistance studies, some sources of variability in studies using fly ash, and to offer some suggestions to improve future test precision and accuracy. General conclusions of this study are, for the materials tested, that there are no significant differences in sulfate resistance for mortars prepared with conventional portland cement and with mortars that partially replace cement with fly ash.

23488 (METC/SP—79/10(Pt.2), pp 579-586) **Ash liability in cement replacement.** Graves, G.P. (American Alloy Steel, Inc., Tucker, GA). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

There is simply no way to completely eliminate all exposure to liability, for it is the imagination of a plaintiff attorney that will challenge every company in the reduction of the incidents of possible negligence. But this does not mean that we can not greatly reduce the exposure that we submit ourselves to daily as we engage in commerce. As I mentioned in the opening remarks, it is no longer a safe position to be in business; we no longer have the attitude of caveat emptor, let the buyer beware. The current climate in this country, fostered by our governments at all levels and supported by an increasingly willing population to seek redress by litigation, we have the attitude of caveat venditor, let the seller beware. If you do not beware of the pitfalls of liability that can be involved in the distribution and sale of fly ash, then, eventually, you will lose or at least settle out of court on the advice of your liability insurance carrier, a questionable case of liability. The real reason will be because you can not support your position. It is necessary to prove, as a defendant, that you did not cause the resultant damage to person or property. Heed well the admonition, that it is not enough to be without blame, you must be able to prove that you are without blemish. When a plaintiff enters a jury trial the sympathy of the jury is already with the plaintiff. As a business enterprise, you the defendent are an immediate suspect. If there is any doubt, the jury, aware that any damages awarded will come from an insurance carrier and not from the business, will resolve in favor of the injured party.

23489 (METC/SP—79/10(Pt.2), pp 587-609) **Fly ash in paving and structural concrete.** Fowler, G.G. (Georgia Dept. of Transportation, Forest Park); Styron, R.W. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The use of fly ash for structural and paving concrete should be considered and evaluated whenever a quality fly ash is available. A proper or established mix design procedure should be followed to assure successful concrete results. A variety of successful projects are illustrated by photographs.

23490 (METC/SP—79/10(Pt.2), pp 610-623) **Sources of pozzolanic activities in fly ashes: a critical review.** Joshi, R.C. (Univ. of Calgary, Canada). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

A critical review of the sources of pozzolanic activity in fly ash, as determined by various investigators from the study of industrial and synthetic ashes, is presented. Important factors which influence fly ash properties are discussed. The effect of variations in physical and chemical properties on fly ash reactivity are reviewed. Chemical tests to evaluate pozzolanic activity of fly ash, suggested by some investigators, are discussed. The results of these studies on industrial and synthetic fly ashes indicate that: (1) the fly ashes produced by suspension fired furnaces should generally be pozzolanic because they are produced by rapid heating and quenching of minerals associated with coals; (2) the degree of pozzolanic activity is related to the amount of strained glass and not the amount of total glass in fly ash; (3) chemical composition of the strained glass in fly ash also controls the pozzolanic activity. Iron tends to reduce the pozzolanic activity whereas calcium apparently increases the ash reactivity; and (4) further research is needed to devise a test which may be used to determine the amount and type of glass in fly ash. Such a test will eliminate the redundant test requirements of the current specifications. Tests suggested by various investigators are either not satisfactory or only partially satisfactory and cannot replace the current specifications which have worked for a long time. However, a quick and reliable test to predict pozzolanic reactivity is long overdue.

23491 (METC/SP—79/10(Pt.2), pp 624-630) **Criterion of estimating the efficiency of fly-ashes in cements and concretes.** Nicolescu, L.D. (Faculty of Land Reclamation Improvement, Bucharest, Romania). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The thesis is developed according to which the efficiency of flying ash in cements and concretes is determined by the chemical activity, expressed by the amount of fixed CaO, on the one hand, and by the amount of added water required to prepare a paste of normal consistency, on the other hand. The pozzolanic effect, estimated by the variation of compression resistances expresses the efficiency of fly ash as a result of the association of these two properties. The efficiency of fly ash (E) may be expressed by the ratio E = Ac/A (Ac = chemical activity, A = amount of added water for the paste of normal consistency) and increases with the value of this ratio.

23492 (METC/SP—79/10(Pt.2), pp 631-652) **Research and utilization of Indian fly ashes in cement manufacture: an overview.** Chopra, S.K.; Narang, K.C.; Babu, K.H.; Sharma, R.B. (Cement Research Inst. of India, New Delhi). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Apart from increasing the availability of cement in a country, use of fly ash for manufacturing cement results in the added advantages of savings in fuel and energy costs and conservation of raw materials. In view of this, large scale utilization of fly ash in cement manufacture is being advocated in India and recommendations have been made for the manufacture of 1.5 million tons of fly ash cement in order to bridge the current gap of 2 million tons of cement between the supply and the demand to the maximum extent. In this context, the authors had made comprehensive investigations on the total and usable quantity of fly ash currently available, evaluation of

their respective quality vis-a-vis national and international standards, effect of fly ash quality variations on the properties of cement produced from it and techno-economic feasibility of production of fly ash cements. The paper briefly reports on these and highlights the effects of the relatively lesser studied parameters such as variations in quality of fly ash; clinker fly ash compatibility and grindability; strength and other properties of fly ash cements; designing of fly ash cement formulations; choice of manufacturing techniques and problems of transportation of fly ash, in-plant handling, storage and processing, etc. The paper also discusses economy of production of fly ash cements for the benefit of a developing country like India.

23493 (METC/SP—79/10(Pt.2), pp 653-658) **New Trief cement process: what has become of Trief cement and portland industry since 1976.** Trief, L. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The author reports development inprovements in his process and new association with engineering companies familiar with kilns and civil engineering construction and also a grant of $250,000, apparently from the Belgian government. On this basis he hopes to take his present laboratory scale results and demonstrate the technical and economic features of the new process. He discusses the feasibility of small cement plants at power plants in developing countries and elsewhere to reduce transportation costs (of either fly ash or the finished cement or both). The process itself is not described in this paper, but a reference is given. He also discusses the feasibility of the most obsolete cement units of USA to use his new fly ash cement technology instead of the old portland one, in close collaboration with the managers of each power station burning coal, for their mutual profit. (LTN)

23494 (METC/SP—79/10(Pt.2), pp 659-678) **Experimental cements with fly ashes.** Nicolescu, L.D. (Faculty of Land Reclamation Improvement, Bucharest, Romania). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Investigations were conducted on two series of experimental concretes made of portland clinker (cement) and fly ashes at a rate of 30% to 70%. The results refer both to the main physical and mechanical properties of the tested concretes and to the long term mechanical strength and hydraulic shrinkage. The relations: deformation-fragility and modulus of elasticity vs percentage of fly ash added are also determined.

23495 (METC/SP—79/10(Pt.2), pp 679-693) **Design and construction of experimental haul road and parking lot facilities utilizing power plant ash.** Head, W.J.; Seals, R.K. (West Virginia Univ., Morgantown). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The design and construction features of a haul road and a parking lot are reported here. These experimental facilities were constructed during the summer of 1978; power plant ash was the major construction material. The base courses of the facilities were stabilized ash/ash mixtures. The wearing courses were emulsified asphalt-stabilized bottom ashes or conventional asphaltic concrete. Materials evaluation techniques are reported; pavement layer thicknesses are selected and construction techniques and problems are illustrated.

23496 (METC/SP—79/10(Pt.2), pp 694-712) **Ash utilization in bikeway construction.** Kraft, D.C. (Univ. of Kansas, Lawrence); Rozelle, J.; Hawk, T.; Johnson, D. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Combinational ash materials were selected for incorporation in a river corridor bikeway project located in Montgomery County, Ohio, as a part of a USDOT Federal Highway Administration Bikeway Demonstration Program. Incinerator ash and fly ash, in some cases stabilized with lime or cement additives, were utilized in the base course of the bikeway section. The bikeway follows the Great Miami River and is 14.77 miles in design length. Results of the material characterization tests, design criteria and mix design tests, together with quantities utilization are presented in summary form. The development of the design and construction specifications together with the initial field construction experiences are also presented.

23497 (METC/SP—79/10(Pt.2), pp 713-724) **Engineering approach for using power plant ash in a structural fill.** Kinder, D.L.; Morrison, R.E. (American Electric Power Service Corp., Charleston, WV). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Utilization of power plant ash in a structural fill presents an exciting alternative for disposal. These materials are a by-product, and not a discarded waste, that provides an economical construction material. We have ignored one of the lage tonnage applications in this country because designers and construction personnel have not been made aware of the technology on using power plant ash in structural fills. During the last five years, AEP has placed about three million tons of ash in structural fills; and at the present time we are engineering three fly ash structural fills that will require over one million tons of ash.

23498 (METC/SP—79/10(Pt.2), pp 725-747) **Experience with geotechnical methods for design of flyash embankments and structural fills.** Ng, S.Y. (Soil Exploration Co., St. Paul, MN). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Many techniques and methods utilized in the field of soil mechanics can be readily adapted for use in the design and construction of flyash embankments and structural fills. As in the field of soil mechanics, it is necessary for an exploration program to be carefully thought out in advance. In this way, the proper tools and techniques can be utilized to obtain the information required for a given project. Previous experiences in the design and construction of flyash embankments should be carefully evaluated in order to gain additional insight into the performance of these materials. In this regard, field monitoring of flyash embankments during and after construction should be considered an essential part of the evaluation process. Since the engineering characteristics of flyash are time, temperature and source dependent, a well designed research program on flyash from any particular source would be of significant value in promoting future construction utilization of that material. Any and all of these activities will be required to advance the current state-of-the-art and build confidence in the suitability of flyash as a practical construction material.

23499 (METC/SP—79/10(Pt.2), pp 748-757) **Delayed compaction of high calcium fly ash stabilized soil.** Thornton, S.I.; Parker, D.G.; Yang, S.N. (Univ. of Arkansas, Fayetteville). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Calcium content of fly ash, reported as calcium oxide, ranged from 20 to 30% by weight for the three fly ash samples tested. All of the samples were self hardening, i.e., they developed unconfined compressive strength when mixed with water. These ashes were produced from Campbell County and Gillette, Wyoming coal. The strength of soil-high calcium fly ash mixtures develops rapidly when compacted immediately after mixing. Seven day unconfined strengths up to 1800 psi were obtained from 20% fly ash and 80% sand mixtures. A time delay between mixing the fly ash with soil and compaction of the mixture reduced the strength greatly. With two hours delay, over a third of the strength was lost, and after four hours delay the loss was over half. One ash, an exception, increased in strength up to two hours delay. With four hours delay, the exception had lost only 23% of its original 1300 psi no delay strength. Gypsum and some commercial concrete retarders were effective in reducing the effect of delayed compaction.

23500 (METC/SP—79/10(Pt.2), pp 758-778) **Performance of waste coal ash as highway subbase course.** Culley, R.W. (Saskatchewan Highways and Transportation, Regina, Canada); Smail, O.H. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

In order to evaluate long-term performance of waste coal as as subbase material for highway pavements, a full-scale test section was constructed in 1976 to 1977 on a two lane rural highway carrying 500 v.p.d. The test section is 2.99 km in length and consists of 53 cm and 46 cm of ash surfaced with 76 mm of asphaltic concrete. This report contains details of the design and construction of the test section. Initial performance after 12 months in service is also discussed. A brief outline of a follow-on project 25.7 km in length that resulted from the test section is also presented.

23501 (METC/SP—79/10(Pt.2), pp 779-783) **Fly ash/boiler slag road bases.** Salow, G. (General Electric Co., Erie, PA). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

This paper deals with the concept of combining fly ash and boiler slag to build road bases. Two roads were built on General Electric property in 1977 using different mix designs. The purpose was two-fold: to provide necessary roads at reduced cost and to provide visual proof that these roads hold up well despite the rugged winters which occur in this area. It is hoped that road building people will take note of this method and be able to reduce the cost of road building.

23502 (METC/SP—79/10(Pt.2), pp 787-804) **Material characteristics of power plant bottom ashes and their performance in bituminous mixtures: a laboratory investigation.** Majidzadeh, K.; Bokowski, G.; El-Mitiny, R. (Ohio State Univ., Columbus). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

While bottom ashes have been used as full or partial substitutes for conventional aggregates in bituminous mixtures, technical data on the material and engineering properties and performance of these materials has been quite limited. A comprehensive investigation was initiated at Ohio State University to provide additional data on the properties of bottom ashes and their performance in paving mixtures. The study yielded surprising data on behavior of ash aggregates in the presence of moisture. Unlike conventional paving mixes, ash-bitumen blends appear to gain strength and durability when saturated, suggesting that thinner, more durable wearing courses might be developed at an economical savings. The investigation included a study of the effects of ash content on mixture density, stability, flow and air voids, using a series of blends in which ashes were used in varying combinations with conventional aggregates. A set of user guidelines was developed for bottom ash aggregates and it was suggested that freeze-thaw cycling and a test similar to the British crushing test might be accurate indicators of material durability and could be conducted in lieu of, or in conjunction with, Los Angeles abrasion and soundness tests. On the basis of the test results discussed above, it can be concluded that, using conventional aggregate testing procedures, the properties of most wet and dry bottom ashes can meet specification limits set for conventional materials. And like conventional materials, dry bottom ash moisture-density relations show a dependency on compaction methods, although wet bottom ashes are relatively insensitive to this variable and their densities are relatively unchanged by variations in moisture content.

23503 (METC/SP—79/10(Pt.2), pp 805-809) **Advances in marketing Pozzolanic road bases.** Merkel, R.T. (N-Viro Energy Systems, Inc., Toledo, OH). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The times favor pozzolanic concretes. Energy savings, by-product utilization, conservation of resources, economics, and balance of payment deficit, all fit the product and hold promise for a viable future.

23504 (METC/SP—79/10(Pt.2), pp 810-815) **Some properties of a highly ash-loaded cementitious binder.** Kestner, M.O.; Kittle, P.A. (Apollo Chemical Corp., Whippany, NJ). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

We have demonstrated the preparation of a cementitious material whose maximum strengths are developed only at high ash loadings in contrast to the trend of research in blended cements which has dominated the field for 30 years. Our M20 binder requires mixing with only fly ash and water - no high temperature processing.

23505 (METC/SP—79/10(Pt.2), pp 866-872) **Disposal of high alkaline fly ash sludge in a decoaled mine seam.** Manz, O.E.; Gullicks, H.A. (Univ. of North Dakota, Grand Forks). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The UND Engineering Experiment Station has not collected sufficient data at this time to make the determination of whether or not the disposal of untreated lignite fly ash FGD sludge at the Center mine will cause significant degradation of groundwater quality. The study hopes to show whether or not the sludge disposal at the Center site is environmentally acceptable, and to show whether vee or bottom of the decoaled mine seam disposal is most acceptable. The study would also show what problems the power and mining personnel must deal with in handling and disposal techniques. The potential for pollution certainly may exist if improper solid waste disposal techniques are used for FGD sludge. Nevertheless, it is imperative that proper methods of disposal be found and employed to handle the increasing volumes of FGD sludges and other wastes. For these reasons the cooperative efforts of government, education facilities, and all branches of industry, including the AWWA, are so vitally important to minimize pollution and to assure safe drinking waters for the future.

23506 (METC/SP—79/10(Pt.2), pp 873-884) **Utilization of ash and scrubber sludge in agriculture: a systems study.** Nebgen, J.W.; Aleti, A.; Snyder, M.K. (Midwest Research Inst., Kansas City, MO). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

This paper discusses findings of a study sponsored by several Kansas Utilities through the Electric Power Research Institute in which the potential for using ash and scrubber sludge to benefit Kansas agriculture has been analyzed in depth. Unlike other studies which have emphasized agronomic aspects of power plant by-products, this study has been conducted from a total systems point of view. Results indicate that ash and sludge waste products are, in principle, assets to agriculture when applied at rates up to 1000 tons per acre. Costs of disposing of ash and scrubber sludge through agricultural usage in a 10- to 20-mile radius of the power plant are competitive with conventional ponding processes, particularly in cases where ponds have to be lined.

23507 (METC/SP—79/10(Pt.2), pp 885-897) **Revegetation study of eastern and western fly ash.** Schivley, W.W. (Gilbert/Commonwealth, Jackson, MI). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The purpose of this program is to develop a cost-efficient means of establishing desirable vegetation cover at an existing ash disposal site. Desirable vegetation includes grass, legumes, and woody plant species, which ensure soil stabilization in addition to improving the aesthetic quality of the disposal site. The approach utilized in developing the revegetation program includes the analysis of studies performed by other utilities and research organizations, and the use of test plots on the disposal site for continuous monitoring of results. The plots will test various soil additives in combination with a variety of plant species to be studied in terms of adaptability and growth rates over several growing seasons. The results of these findings should establish a range of revegetation options relative to growth rates and desired effect. New legislation and spiraling inflation have forced the energy industry to take a closer look at disposal site reclamation and associated costs. Revegetation is critical to the success of all reclamation planning. Properly implemented, such a program ensures aesthetic compatibility, erosion and sedimentation control, earthwork stability, and growing medium rehabilitation. This paper addresses some revegetation concepts, and a test program based on utilizing inexpensive and common vegetation cover grown in a minimally developed subsurface root medium. Although this program is just one growing season old, early results are encouraging.

23508 (METC/SP—79/10(Pt.2), pp 904-910) **Lime/fly ash injection applications.** Wright, P.J. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Injection of hydrated lime slurry is an established stabilization technique with a variety of applications. Due to increasing costs of hydrated lime and due to widespread availability of good pozzolanic fly ash, there is much opportunity for use of this economical, by-product material for soil stabilization. The injection stabilization system utilizes a slurry mixed in various proportions of lime and fly ash. The slurry is pumped into the soil under pressure using semi-automated, high volume production equipment. Principal applications to date have been for stabilization of railroad beds, building foundations, slopes, dikes, runways, sanitary landfills, and various dewatering stabilization. Continuous injections have been made to depths of 40 feet.

23509 (METC/SP—79/10(Pt.2), pp 911-929) **Use and potential for fly ash in grouting.** Bradbury, H.W. (Hargreaves Industrial Services Ltd., Bramham, England). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The increasing utilization of fly ash as a consultant of civil engineering and constructional grouts and the factors of controlling the choice of such grout mixes, including references to the physical characteristics of fly ash in relation to grouting, and the properties it imparts, e.g., sulfate resistance, impermeability, improved flow and reduced costs. Types of use and the sociological factors which limit the development of its full potential are discussed.

23510 (METC/SP—79/10(Pt.2), pp 930-933) **Fly ash/cement grouts for mine backfilling.** Lamberton, B.A. (Intrusion-Prepakt, Inc., Cleveland, OH). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

This mine backfilling project was performed at the site of a new power station near Masontown, Pennsylvania. The entire area overlies abandoned coal mine workings. Studies made by GAI, Inc., Monroeville, Pennsylvania, indicated that the ground was subsiding due to collapse of these abandoned workings and that structural backfilling would be required under the three main generators, two smokestacks, a cooling tower, and under the coal stacker area. A program was developed in which structural columns were to be installed in the abandoned mine workings on a grid pattern by pouring gravel down drill holes and injecting low-strength grout into the preplaced gravel to form supports which were, in effect, preplaced aggregate concrete columns. Four rotary drills placed six-inch diameter holes to depths ranging from 140 to 180 ft. Casing was required for the upper 30 to 35 ft of overburden. Primary drillholes were spaces on 25-ft centers. In areas subjected to maximum stress, secondary holes were placed at the midpoints between primary holes, resulting in a final grid pattern of about 17 1/2 ft. After drilling, a 1 1/2 in diameter grout pipe was placed to the bottom of the mine workings. Minus 1/2 in crushed limestone was then poured down the drill hole to approximately one foot above the top of the void. It was estimated that the void ranged from four feet to five feet in thickness. A lean fly ash/cement grout was then injected in the aggregate to create grouted gravel columns. Fly ash/cement grout was chosen for greater economy, fluidity, lower shrinkage, and better penetration of the voids of the preplaced aggregate. Typical

grout proportions were 3 cu ft of fly ash per bag of cement with 3 cu ft of water.

23511 (METC/SP—79/10(Pt.2), pp 935-937) **Standard specification for fly ash and raw or calcined natural pozzolan for use as a mineral admixture in portland cement concrete.** 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

23512 (METC/SP—79/10(Pt.2), pp 940-950) **Uniform Commercial Code (UCC), sections from Article 2: sales.** 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

23513 **Method for recovering concentrated sulphur dioxide from waste gases containing sulphur dioxide.** Bengtsson, S. (to Aktiebolaget Svenska Flaktfabriken). US Patent 4,181,506. 1 Jan 1980. Priority date 12 Apr 1977, Sweden, 6p.

Improved efficiency in recovering SO_2 from waste gases is obtained in a system where the SO_2 is absorbed into a solution which is then distilled. The method of this application entails compressing the steam-SO_2 mixture issuing from the still before condensing out the steam, so that the heat from the compressed steam-SO_2 mixture may be used in generating the steam for the still, and the condensate may be recycled through the still, preferably after reheating the same.

23514 **Method of agglomerating fine powders.** Paulson, D.L.; Worthington, R.B. US Patent 4,157,371. 5 Jun 1979. Filed date 19 Mar 1975. 4p.

The invention is used to agglomerate extremely fine flue dust particles in a collection bin and process them before sending the resultant agglomeration to storage or a further processing location. From its collection bin, the dust particles are discharged by gravity upon a lower rapidly rotating smooth horizontal disc. The bin discharge is offset slightly from the disc's center so that the particles are subjected to centrifugal force to move them to the disc's outer periphery. At the point where the particles are discharged on the disc, a liquid binder, like water, is sprayed on the particles to cause them to begin to agglomerate. After being sprayed, the wetted particles are agglomerated under the influence of centrifugal and tangential forces. A scraper may be used to aid in pushing the particles towards the disc's raised outer edge. When they reach the disc's raised edge, the particles are completely agglomerated at which time they fall over the edge into a discharge hopper located below. Except for its slightly raised peripheral edge, the horizontal disc surface is almost perfectly smooth. The disc's shape including its slightly raised peripheral edge insure a short residence time for the wetted particles before they are agglomerated and discharged.

23515 **Treatment of liquid effluents from coal gasification plants.** Eriksson, S.; Prior, M. London, England; NCB (IEA Services) Limited (1979). 71p. (IEA/EAS—B2/79(Draft)). IEA Coal Research, Economic Assessment Service, London, England.

Large coal conversion processes are likely to be subject to stringent environmental scrutiny. It is of interest to assess the economic consequences of anticipated regulations, (a) to take into account environmental costs when making judgements on the likely competitiveness on coal derived gas in the future; (b) when assessing future development trends of various types of gasification plants. This report does not cover all types of emission, gaseous, liquid and solid, and the total environmental costs are not calculated. Solid waste disposal and gaseous emissions are not considered. It is found that liquid effluents from the gasifier, and raw gas cooling and quenching section can cause significant treatment costs which vary widely between gasifier types. These effluents can be more heavily polluted with organic and inorganic matter than other industrial or municipal wastes. Phenols and ammonia are commonly found in high concentrations, together with tars, oil and grease, fatty acid, cyanide and cyanates. Heavy metals and polyaromatic hydrocarbons might also be found in these effluents though at unknown concentrations and with unknown consequences for effluent treatment. Low-temperature, high-pressure fixed-bed processes produce a much more polluted effluent than high temperature, low pressure processes, such as entrained flow units. The resulting costs for treating the liquid effluent from the low temperature process is in the order of 18 to 30 cents/GJ or around 5% of the total gas production cost. Smaller units would incur higher unit treatment costs. The high-temperature process effluent contains much less organic pollutants and is therefore easier to treat. The incremental cost on the gas production is estimated to be much less than 1 cents/GJ.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 23477, 23483, 23507, 23538, 24028, 24037, 24038, 24607, 24617, 24627, 24643, 24652, 24658, 24660, 24767, 24775

23516 (METC/SP—79/10(Pt.2), pp 816-839) **Hillman State Park: final assessment of fly ash as a soil modifier for acidic strip mine spoil.** McLean, E.T.; Dougherty, M.T. (Ackenheil and Associates Geo Systems, Inc., Pittsburgh, PA). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Fly ash was applied to approximately 180 acres of strip mine spoils to determine the effect upon grain size distribution, moisture retention, and spoil pH following strip mine reclamation of Hillman State Park, Pennsylvania. Before-after comparisons of spoil pH, moisture retention and grain size distribution were performed. Results indicated statistical differences in spoil pH, moisture retention, and grain size distribution associated with fly ash application.

23517 (METC/SP—79/10(Pt.2), pp 840-865) **Application of fly ash and other wastes to mine soils as an aid in revegetation.** Keefer, R.F.; Singh, R.N.; Doonan, F.; Khawaja, A.R.; Horvath, D.J. (West Virginia Univ., Morgantown). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Alfalfa and lespedeza grown in the greenhouse and field on mine soils amended with factorial combinations of fly ash, sewage sludge and chicken manure showed variable response. Both alfalfa and lespedeza grew well where all three waste materials were applied together. Application of fly ash alone to acid mine soils in both greenhouse and field experiments resulted in poor or no growth of legumes. This lack of response of crops to fly ash alone may have resulted from low levels of P and other nutrients in the fly ash and mine soils or from toxic levels of boron. Fly ash combined with other waste materials increased soil pH and P levels in alfalfa and decreased levels of toxic elements such as Al, Mn in soil and Ni concentration in plants. These results indicate that combined application of three waste materials complimented each other by providing essential nutrients and immobilizing elements toxic to crops.

23518 (ORO—4946-T1) **Effects of contour coal strip mining on stormwater runoff and quality.** Overton, D.E.; Crosby, E.C. (Tennessee Univ., Knoxville (USA). Dept. of Civil Engineering). Sep 1979. Contract EY-76-S-05-4946. 151p. NTIS, PC A08/MF A01.

A mathematical model for simulating stormwater response and pollutant yield in strip mined watersheds was developed. This model consisted of a storm hydrograph simulator, a watershed pollutant load simulator and a site erosion simulator. The storm hydrograph simulator, TENN-I, has been optimized for the Tennessee Valley and can be used for both gauged and ungauged watersheds. The watershed soil load simulator, LOAD-I, was based upon development of a suspended load modulus that can be derived from storm hydrographs and sedigraphs. The site specific soil erosion model, ERODE-I, was based upon soil erosion mechanics and overland flow. Erosion, runoff, sediment delivery and total loads were simulated for storm events on both a real time basis and on a design storm basis. A regionalization scheme associated with the model permitted simulation of the effects of alternative development scenarios on stormwater and suspended load. Comparisons of the model are made with pollutant yields from watersheds which have undergone coal contour strip mining and urbanization. This model's ability to relate a watershed's stormwater runoff and pollutant load to measurable, quantifiable, and readily comparable quantities provides a powerful tool to evaluate the effects of land use change before the fact.

23519 (PB—299887) **Control of vibration and blast noise from surface coal mining. Volume I. Open file report (final) 1 July 1975-28 February 1978.** Wiss, J.F.; Linehan, P.W. (Wiss, Janney, Elstner and Associates, Inc., Northbrook, IL (USA)). Dec 1978. Contract J0255022. 161p. NTIS, PC A08/MF A01.

A series of controlled experiments was conducted at four surface coal mines to study the effects of certain blast parameters upon the ground and air vibration. Preliminary scale-model blasts were conducted at a quarry to provide basic data. This report is a literature review of the investigation.

23520 (PB—299888) **Control of vibration and blast noise from surface coal mining. Volume II. Open file report (final) 1 July 1975-28 February 1978.** Wiss, J.F.; Linehan, P.W. (Wiss, Janney, Elstner and Associates, Inc., Northbrook, IL (USA)). Dec 1978. Contract J0255022. 282p. NTIS, PC A13/MF A01.

A series of controlled experiments was conducted at four surface coal mines to study the effects of certain blast parameters upon the ground and air vibration. Preliminary scale-model blasts were conducted at a quarry to provide basic data. This report describes the experiments conducted at the mines and the variables evaluated are identified. The effects of the variables upon the peak amplitudes and frequency content of the seismic and air vibrations are included.

23521 (PB—299889) **Control of vibration and blast noise from surface coal mining. Volume III. Open file report (final) 1 July 1975-28 February 1978.** Wiss, J.F.; Linehan, P.W. (Wiss, Janney, Elstner

and Associates, Inc., Northbrook, IL (USA)). Dec 1978. Contract J0255022. 626p. NTIS, PC A99/MF A01.

A series of controlled experiments was conducted at four surface coal mines to study the effects of certain blast parameters upon the ground and air vibration. Preliminary scale-model blasts were conducted at a quarry to provide basic data. This report presents tabulations of the test results.

23522 (PB—299890) **Control of vibration and blast noise from surface coal mining. Volume IV. Executive report. Open file report (final) 1 July 1975-28 February 1978.** Wiss, J.F.; Linehan, P.W. (Wiss, Janney, Elstner and Associates, Inc., Northbrook, IL (USA)). Dec 1978. Contract J0255022. 50p. NTIS, PC A03/MF A01.

A series of controlled experiments was conducted at four surface coal mines to study the effects of certain blast parameters upon the ground and air vibration. Preliminary scale-model blasts were conducted at a quarry to provide basic data. This report presents an analysis of the data obtained from the field tests. Where possible, expressions have been developed that will be helpful in establishing guidelines for the design of blasting to minimize adverse results with respect to noise and ground vibration.

23523 (PB—299926) **Development of an area sampling methodology. Open file report (final) June 73-October 1975.** Harris, H.E.; DeSieghardt, W.C.; Riva, L.A. (Eastern Associated Coal Corp., Everett, MA (USA). Dept. of Research and Development). Oct 1976. Contract H0133108. 99p. NTIS, PC A05/MF A01.

No abstract available.

23524 (PB—299963) **Demonstrating the noise control of a coal preparation plant. Volume I. Initial installation and treatment evaluation. Open file report (final).** Rubin, M.N. (Bolt, Beranek, and Newman, Inc., Cambridge, MA (USA)). Sep 1977. Contract H0155155. 182p. NTIS, PC A09/MF A01.

A coal preparation plant was selected to demonstrate various noise control techniques and materials in a commercially operating plant. At the start of the project, the 1,650-ton-per-hour (tph) plant was surveyed to document the existing sound levels and worker noise exposures. On the basis of the survey, individual noise sources were characterized and assigned priorities for treatment. Four categories of noise control treatments were installed in this plant: resilient impact pads, curtains, chute liners, and resilient screen decks. Currently (1977) available resilient impact pads and curtains were suitable for general use in coal preparation plants, and they provided significant noise reduction (6 to 10 dB(A)). The overall performance of the chute liners, which also provided useful noise reduction, was strongly dependent on the specific installation. Although the resilient screen decks have the potential for 7 to 9 dB(A) of coal/screen impact noise reduction, blinding and delamination (in composite decks) encountered at the Georgetown Plant represented major design problems for these products. This program achieved noise reductions up to 10 dB in various areas of the plant (within the restrictions imposed by the plant's operation) resulting in significant reduction in worker noise exposures.

23525 (PB—300540) **Environmental assessment of surface mining methods: head-of-hollow fill and mountaintop removal. Interim report November 1975-January 1977.** Robins, J.D.; Hutchins, J.C. (Skelly and Loy, Harrisburg, PA (USA)). Jul 1979. Contract EPA-68-03-2356. 223p. NTIS, PC A10/MF A01.

The study explores the environmental impact of the mining and reclamation techniques employed in West Virginia and Kentucky mountaintop removal and head-of-hollow fill sites. The project is divided into four major phases, the first three of which are discussed in this Interim Report: I. State-of-the-Art Review, II. General Environmental Assessment of West Virginia and Kentucky Mines Sites, III. Intensive Mine Site Monitoring and Environmental Assessment in Both States, and IV. Evaluation and Update of Construction Guidelines.

23526 (PB—300671) **Environmental assessment of coal cleaning processes; first annual report. Volume I. Executive summary. Annual report July 1976-September 1977.** Lemmon, A.W. Jr; Rogers, S.E.; Robinson, G.L.; Hale, V.Q.; Raines, G.E. (Battelle Columbus Labs., OH (USA)). Jun 1979. Contract EPA-68-02-2163. 75p. NTIS, PC A04/MF A01.

The report gives results of the first year's work on an environmental assessment of coal cleaning processes. A short base of engineering, ecological, pollution control, and cost data is being established through data gathering and systems analysis efforts. In addition to program management, three task areas are defined: system studies, data acquisition, and general program support. Early availability is anticipated for draft reports of progress for three subtasks: (a) developing information on coal cleaning process technology; (b) defining the technological and cost status of the control of pollutants from coal cleaning and refusal disposal; and (c) establishing criteria for meeting environmental goals. (A fourth subtask, acquiring process data, was terminated to avoid duplication.) Progress has been made on data acquisition subtasks, aimed at the planning needed as the forerunner of the anticipated environmental field testing program: (a) developing and describing the overall environmental test program; (b) developing the rationale for selection and selecting the evaluation sites; (c) specifying the experimental testing techniques to be used; and (d) developing the master site test plan. (Ten site categories have been specified for testing.) General program support includes: (a) obtaining background environmental data, and (b) operating a coal cleaning information center.

23527 (PB—300672) **Environmental assessment of coal cleaning processes; first annual report. Volume II. Detailed report. Annual report July 1976-September 1977.** Lemmon, A.W. Jr; Rogers, .E.; Robinson, G.L.; Hale, V.Q.; Raines, G.E. (Battelle Columbus Labs., OH (USA)). Jun 1979. Contract EPA-68-02-2163. 188p. NTIS, PC A09/MF A01.

The following topics are discussed: current environmental background; Environmental objectives development; Environmental data acquisition; Control technology assessment; Environmental alternatives analysis; Technology transfer; Future efforts.

23528 (PB—300673) **Environmental assessment of coal cleaning processes; selection of test sites for source test program. Final report December 1977-December 1978.** Tolle, D.A.; Thomas, R.E.; Markarian, R.K.; Hale, V.Q. (Battelle Columbus Labs., OH (USA)). Jul 1979. Contract EPA-68-02-2163. 65p. NTIS, PC A04/MF A01.

The report describes the selection of coal cleaning plants at which field testing and sampling will be conducted to support the environmental assessment of the pollution potential of various coal cleaning processes. The approach was to select a few plants (representing extremes in variables considered important in evaluating the pollution potential of these types of plants) from which data may be obtained. Site selection involved: (1) classifying plants into a number of site categories; and (2) gathering additional detailed information on specific plants and applying secondary constraints to a single suitable site for sampling in each site category identified in step (1). Step (1) assumes that all sites are equal within each category; in step (2), however, the best or most representative site within a category is to be selected. Classifying plants into various site categories is based on four criteria (variables): the acid neutralization potential of the soil surrounding the plant, the pyritic sulfur content of run-of-mine coal, the average annual precipitation, and the process technology. An initial sorting of the more than 400 known coal cleaning plants produced lists of plants which correspond to each of the 10 site categories. Imposing constraints reduced the number of potential test sites to 45. Site visits, to acquire additional information, are necessary before the final sampling sites can be selected.

23529 (PB—301249) **Evaluation of the environmental effects of western surface coal mining. Volume II. Mine inventory. Final report.** Kelly, W. (Mathtech, Inc., Princeton, NJ (USA)). Feb 1979. Contract EPA-68-03-2226. 206p. NTIS, PC A10/MF A01.

This report contains a tabular summary of general information for 37 surface coal mines active in the western United States during 1975 and for seven additional mines that were under development in that year. In total, 44 mines in the following states are included: Arizona, Colorado, Montana, New Mexico, North Dakota, and Wyoming. Types of information presented includes: General production information, including 1975, production and projected maximum production; mine life, employment, and disturbed acreage; Coal seam characteristics, including average thickness, heating value, sulfur content, and ash content; Reclamation practices; Types of mining and reclamation research studies in progress; Overburden characteristics, pit geometry, and mining methods; Equipment types and capacities for major stripping equipments only.

23530 (PB—301253) **Strip coal mining and mined-land reclamation in the hydrologic system, southeastern Montana. Project completion report.** Van Voast, W.A.; Hedges, R.B.; McDermott, J.J. (Montana Bureau of Mines and Geology, Butte (USA)). Dec 1978. Contract OWRC-10570165. 128p. NTIS, PC A07/MF A01.

Coal beds which are locally important aquifers for southeastern Montan's agricultural economy are being removal as mining development occurs. Overburden rock materials (spoils) replace the coal beds as aquifers. As mine pits are backfilled, ground waters readily re-enter the spoils. The chemistry of spoils waters in diverse, reflecting the lithologic and geochemical variability of overburden materials. At Decker, predominant ions in spoils water are sodium and bicarbonate; at Colstrip, they are magnesium, calcium, and sulfate. Statistically, spoils waters in both areas are more highly mineralized than nearby stock and domestic waters. Column backing experiments conducted with spoils produced leachates that were chemically similar to waters found in the field. First pore volumes of the leachate were also chemically similar to saturated-paste extracts. The relationships between saturated-paste-extracts quality and spoils-water quality were utilized to develop generalized nomographs for predicting spoils-water cation concentrations from pre-mining paste-extract chemistry.

23531 Low/medium Btu gasification: a summary of applicable EPA regulations. Gibson, E.D. (Radian Corp., Austin, TX); Page, G.C. pp 32-42 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

From an environmental viewpoint, coal gasification and gas purification are sources of the most significant waste streams from a coal gasification plant. Gasification processes generate air emissions. Vent gases from the coal feeding device contain certain hazardous species which are also found in the raw product gas as it exits the gasifier (i.e., H_2S, HCN, CO, tar/oil, and aerosols). Vent gases are also discharged from the ash removal device. The start-up vent stream from the coal gasifier is another air emission of the gasification operation. Depending on the coal feedstock, the start-up vent stream may contain tar and oil aerosols, sulfur species, cyanides, and other constituents. The coal gasifier is also a source of fugitive emissions which may contain hazardous species present in raw product gas. The only significant liquid waste stream from the gasification operation is the spent ash quench or sluice water discharge from the ash removal device. This stream contains various dissolved and suspended organics and inorganics. Solid waste streams such as ash or slag are also discharged from the ash removal device. These solid waste streams contain unreacted coal, trace elements, and small amounts of various organics. The gas purification operation is a source of various air, liquid, and solid waste streams. Several of the waste streams generated by gasification facilities will probably require the application of control technology in order to comply with environmental regulations. This paper describes those regulations to be considered and then summarizes the specific waste streams requiring some type of control. The choice of a specific control system depends on several variables and is not addressed in this paper.

23532 Observations on boron release from coal-fired power plants. Gladney, E.S.; Wangen, L.E.; Curtis, D.B.; Jurney, E.T. (Los Alamos Scientific Lab., NM). *Environ. Sci. Technol.;* **12**: 1084(Sep 1978).

The boron content of coal and power plant process ashes is investigated. Calculation of mass balances suggests that a large fraction of the boron is being released to the atmosphere.

RESERVES AND EXPLORATION

23533 (CONF-790949—3) **Coal.** McNeese, L.E. (Oak Ridge National Lab., TN (USA)). 26 Sep 1979. Contract W-7405-ENG-26. 40p. Dep. NTIS, PC A03/MF A01.

From Energy resources workshop; Oak Ridge, TN, USA (24 Sep 1979).

This conference presentation or coal includes mostly tables and graphs on world coal reserves and resources (major countries separately), coal production and consumption, trade, markets, uses, historical trends in USA, time reserves will last under various assumptions (139-5000 yrs), boiler fuels (economics), environmental effects, health hazards of coal, nuclear, oil, natural gas and hydro, US DOE energy research programs, fluidized bed-combustion of coal, coal gasification, coal liquefaction and international cooperation in coal research programs. (LTN)

23534 (PB—301108) **Kaiparowits handbook, coal resources (Lake Powell Research Project, interim report).** Carey, D.; Wegner, J.; Anderson, O.; Weatherford, G.; Perkins, P. (California Univ., Los Angeles (USA). Inst. of Geophysics and Planetary Physics). May 1975. 121p. NTIS, PC A06/MF A01.

A detailed survey of various aspects of coal in the Kaiparowits region of Utah is reported. The presentation comprises three parts: (1) coal resources: (2) legal ownership and controls; and(3) future outlook for coal development. The geologic history of the region is reviewed. The rank, quality, and mineability of the region's coal are characterized. Future development of the Kaiparowits coalfield is linked to the regional and national energy supply-demand situation. The constraints influencing such development are discussed.

23535 Lignite drilling during 1978 in western North Dakota: Adams, Billings, Bowman, Burke, Golden Valley, Hettinger, McKenzie, McLean, and Slope Counties. Grand Forks, ND; North Dakota Geological Survey (1979). vp. $67.50.

This report contains maps showing locations, logs (gamma ray, density, self potential and resistivity) and sample descriptions for the 131 testholes. It also contains analyses of 7 lignite cores.

MINING

REFER ALSO TO CITATION(S) 23510, 23516, 23517, 23529, 23565, 23570, 24569

23536 (FE—3134-1) **Manpower for the coal mining industry: an assessment of adequacy through the year 2000. Volume I. Executive summary. Final technical report.** Rosenberg, J.I.; Mendis, M.S.; Medville, D.M. (Mitre Corp., McLean, VA (USA). METREK Div.). Mar 1980. Contract ET-78-C-01-3134. 15p. (MTR—79W00325-01). NTIS, PC A02/MF A01.

This report presents a summary of the analytical approach taken and the conclusions reached in an assessment of the supply and demand for manpower in the coal mining industry through the year 2000. A hybrid system dynamics/econometric model of the coal mining industry was developed which incorporates relationships between technological change, labor productivity, production costs, wages, graduation rates, and other key variables in estimating imbalances between labor supply and demand. Study results indicate that while the supply of production workers is expected to be sufficient under most future demand scenarios, periodic shortages of experienced workers, especially in the Northern Great Plains, can be expected. Other study findings are that the supply of mining engineers will be sufficient under all but the highest coal demand scenario; a shortage of faculty will affect the supply of mining engineers in the near term; and the employment of mining technicians is expected to exhibit the largest increase in any labor category studied. This volume is an Executive Summary which provides a brief description of the study and gives its major conclusions and recommendations. An accompanying volume (Vol. 11) provides a detailed description of the analytical basis for the study, the sources of data used, and a discussion of the conclusions reached.

23537 (FE—3134-2) **Manpower for the coal mining industry: an assessment of adequacy through the year 2000. Volume II. Technical approach. Final technical report.** Mendis, M.S.; Rosenberg, J.I.; Medville, D.M.; Stokes, B.A.; Reierson, J.D.; Cumiskey, P.L. (Mitre Corp., McLean, VA (USA). METREK Div.). Mar 1980. Contract ET-78-C-01-3134. 395p. (MTR—79W00325-02). NTIS, PC A17/MF A01.

This report presents a summary of the analytical approach taken and the conclusions reached in an assessment of the supply and demand for manpower in the coal mining industry through the year 2000. A hybrid system dynamics/econometric model of the coal mining industry was developed which incorporates relationships between technological change, labor productivity, production costs, wages, graduation rates, and other key variables in estimating imbalances between labor supply and demand. Study results indicate that while the supply of production workers is expected to be sufficient under most future demand scenarios, periodic shortages of experienced workers, especially in the Northern Great Plains can be expected. Other study findings are that the supply of mining engineers will be sufficient under all but the highest coal demand scenario, a shortage of faculty will affect the supply of mining engineers in the near-term and the employment of mining technicians is expected to exhibit the largest increase in any labor category studied. In this volume the nature of the coal mining manpower problem is discussed, a detailed description of that analysis conducted and the sources of data used is provided, and the findings of the study are presented.

23538 (SAND—80-0537) **Evaluation of European empirical methods for subsidence in US coal fields.** Munson, D.E.; Eichfeld, W.F. (Sandia National Labs., Albuquerque, NM (USA); Department of Energy, Carbondale, IL (USA). Carbondale Mining Technology Center). Apr 1980. Contract EY-76-C-04-0789. 27p. NTIS, PC A03/MF A01.

The purpose of this study was to assess the applicability of European subsidence methods for the emerging US longwall practice. Subsidence prediction in Europe has typically used either graphical methods (United Kingdom) or mathematical methods. The mathematical methods utilize either profile or influence functions. The graphical methods were developed in the United Kingdom (UK) by the National Coal Board (NCB) from subsidence data obtained from numerous mines. Although a large data base in the United States (US) is not available, the methods can be tested against some recent measurements of subsidence of an essentially flat deposit mined at a depth of 189 m in the Illinois Coal Basin. While the total predicted subsidence by the NCB method is approximately correct, the profile shapes are not well matched. On the other hand, the profile functions, which are fundamentally independent of orientation with respect to mining, give quite accurate representation of the measured profiles. Of the antisymmetric forms tried, a trigonometric form was slightly preferably because it predicted strains that were conservative, i.e., always somewhat greater than the measured values. These results suggest that much of the European subsidence experience is applicable to US practice. Consistent values of the

parameters were found for profiles with similar initial conditions or similar orientations for two longwall panel results. It should be noted that the actual profiles were always somewhat more complex than the profile functions could adequately handle and that the development curves showed time-dependent effects as well. The magnitude of these time-dependent effects, while possibly small compared to the time-independent or instantaneous subsidence, are of importance and must eventually be incorporated into a proper analysis.

23539 Annotated bibliography on selected areas of coal mining research and development. Report prepared for the Committee on Science and Technology, US House of Representatives, Ninety-Sixth Congress, First Session by the Congressional Research Service, Library of Congress. Washington, DC; Committee on Science and Technology (1979). 56p. GPO.

The Congressional Research Service has completed an annotated bibliography on coal mining research and development. Although the completion of the study was delayed in order to permit CRS analysts to search the libraries of Bituminous Coal, Research Inc., and the Bureau of Mines in the Pittsburgh area, current re-emphasis on the use of coal as an energy source indicates a sustained relevance. The bibliography presents key references to coal-mining R and D under six subject headings keyed to issues of central concern in coal production: (1) mine health and safety, (2) methane recovery, (3) 1-hour rescuer, (4) use of diesels underground, (5) coal preparation, and (6) manpower development in coal mining.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 23562

23540 (FE—9145-1) **Evaluation of the effects of coal cleaning on fugitive elements. Phase I. Final report, March 1, 1977-January 31, 1978.** Ford, C.T.; Moses, R.G. (Bituminous Coal Research, Inc., Monroeville, PA (USA)). 17 Aug 1978. Contract ET-77-C-01-9145. 277p. (BCR-L—923). NTIS, PC A13/MF A01.

By virtue of its origin, coal contains nearly every naturally-occurring element. With the exception of carbon, hydrogen, oxygen, nitrogen, and sulfur, which are the principal constituents of coal, as well as iron, aluminum, silicon, and the alkaline earth metals in the ash, most elements are present in minor or trace amounts. During coal mining, preparation, and utilization, these elements may be released to the environment. Even though these fugitive elements are normally present at extremely low levels, it may not be possible to ignore them as some are known to be harmful to plant and animal life at relatively low concentrations. The problem may, in fact, be compounded due to the large coal tonnage consumed in electric power generation and the anticipated consumption for coal conversion. Within the past few years several trace elements, specifically mercury, cadmium, lead, arsenic, and selenium, have been pointed to with increasing frequency as potential environmental problems, and the coal industry has been indicated as a major contributor to the levels found in the environment. The need to better understand the fate of fugitive elements during coal mining, preparation, and combustion processes is imperative; however, to date, few systematic studies have been undertaken. The present, on-going project is an initial step in that direction. Two coals, one a mixture of Upper and Lower Freeport seams and the other an Illinois No. 6 seam, were subjected to extensive cleaning and the separated fractions were thoroughly analyzed. The data were used in evaluating the effect of such cleaning on fugitive elements, those constituents which might be released during mining or utilization in sufficient quantities to adversely affect the environment.

23541 (LA-UR—80-551) **Kinetic behavior of subbituminous coal drying; effects of confining pressure.** Brown, L.F.; Kashiwa, B.A.; Vanderborgh, N.E.; Corlett, R.C. (Los Alamos Scientific Lab., NM (USA); Washington Univ., Seattle (USA). Dept. of Mechanical Engineering). 1980. Contract W-7405-ENG-36. 10p. (CONF-800710—1). Dep. NTIS, PC A02/MF A01.

From Drying '80 conference; Montreal, Quebec, Canada (7 Jul 1980).

A model is developed which explains the drying behavior of a subbituminous coal. This model, a variation of the moving-boundary approach, has the vapor-liquid interface in the macropores receding from the exterior surface of the coal as drying progresses. On the liquid side of the interface, liquid water exists in all three pore systems - macropores, transitional pores, and micropores. On the vapor side of the interface, in the transitional and micropore systems branching off the macropores, the moisture essentially is in equilibrium with the water vapor in the macropore system. Water diffuses from the liquid interface in the macropores through these pores to the exterior surface of the coal. Experiments with a Washington State subbituminous coal are described which test this model. The predictions of the model match the behavior of experimental drying curves. The effective diffusivities obtained were within the range expected for the constricted pore systems which coal possesses. Higher initial stresses apparently decrease the total porosity and increase the severity of pore constrictions. Disparities between model prediction and experimental behavior, which occurred at a late drying time, result from the assumed water adsorption isotherm.

23542 (METC/SP—79/10(Pt.1), pp 140-164) **Use of the magnetic fraction of fly ash as a heavy medium material in coal washing.** Roy, N.K. (Indian Inst. of Tech., Kharagpur, India); Murtha, M.J.; Burnet, G. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Several bituminous coal fly ashes were fractionated in a dry state using a moving-field electromagnetic separator. The sedimentation and rheological characteristics of suspensions of the magnetic fraction recovered from one of these ashes were determined and compared with those of suspensions prepared from an industrial grade magnetite sample. Effects of grinding and washing the magnetic fraction and of the addition of contaminants were also evaluated. Results indicated that the magnetic fraction of power plant fly ashes compares favorably with industrial magnetite as a heavy medium material. Preliminary studies with heavy medium beneficiation of a coal sample using the magnetic fraction of a typical fly ash confirmed that this material is quite suitable in coal washing. A cost analysis showed that a modest investment in magnetic separation and grinding equipment could result in recovery of a significant amount of marketable heavy medium material from the waste coal ashes of many large US power plants burning bituminous coals. In addition, the amount of plant fly ash for disposal would be reduced by about 15 percent.

23543 Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979). 368p. (CONF-7806123—).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

This Symposium was conducted under the auspices of the Maritime Transportation Research Board (MTRB) of the National Academy of Sciences/National Research Council, as a part of a continuing program of advice to the federal government directed toward improving maritime and maritime-related transportation. This study was undertaken at the request of MTRB's sponsors. The Symposium addressing Critical Issues in Coal Transportation Systems, held June 14-15, 1978, consisted of sixteen papers addressing economic, security, labor, circuitry, regulatory, and technological issues affecting the transportation of coal. The modes addressed by the papers included rail, pipeline, inland waterways, Great Lakes, and ocean. Extensive question and answer sessions followed each delivered paper. Fifteen papers from the proceedings have been entered individually into EDB, ERA, and EAPA. (LTN)

23544 Factors affecting US coal use in the next two decades. Draffin, C.W. (Department of Energy, Washington, DC). pp 1-36 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

The dramatic increase in the use of coal from 1980 to 2000 will be due to its increased use in both steam and process heat applications. You, as leaders in the coal transportation system, need to effectively meet current demands while preparing for the future. You will need to be sensitive to industrial users requiring more stringent coal specifications, to utilities purchasing western coal supplies that require cross-country shipping, and to the trends and uncertainties regarding future coal use. It will be important to plan for different economic and regulatory conditions. Although the transportation industry should be hesistant to commit to major capital expenditures in rail cars, locomotives, barges, and pipelines until the coal demand is secure, prior system planning will be essential. You should carefully consider a wide range of demands and make the necessary long lead-time improvements to maintain options for responding to future transportation demands. In addition, incorporation of a systems approach into your planning process should make the future US coal transportation system more efficient and more profitable. We, in the Fossil Energy Office of the US Department of Energy have tried to do the same thing. We are examining the entire coal fuel cycle (including mining, preparation, handling, transportation, combustion, gasification or liquefaction, and final end use) to make sure there are not environmental or technical impediments to coal use.

23545 Overview of critical issues in coal transportation systems. Desai, S.A. (Input Output Computer Systems, Inc., Cambridge, MA). pp 37-51 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

I have covered a few of the most critical of the issues to indicate the sources of the problems and to highlight the fact that

they are all interrelated. In the final analysis, the transportation industries are going to have to invest enormous amounts of capital to handle projected coal traffic. If the profitability of the traffic, the long-term growth of the traffic, or the technological, institutional, or regulatory factors surrounding coal production, consumption, and transportation are left in uncertainty. The ability of all modes to raise the needed capital will be impaired.

23546 Economics of oceanborne coal transportation. Hettena, R. (Maritime Overseas Corp., New York, NY). pp 53-93 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

Coal carriers - along with other bulk ships - operate in a highly competitive market. The market approaches the ideal of pure competition. The shipowners are numerous, geographically dispersed, and operate their vessels worldwide with complete mobility between trades. They can shift easily and rapidly from one dry-bulk commodity to another. Entry into and exit from the bulk-shipping business is completely unrestricted. The industry is totally unregulated, and the market where bulk-shipping services are bought and sold is large and well developed. There is no significant differentiation in the provision of shipping services. Bulk shipowners are contract carriers and engage in price competition. Economies-of-scale are an important determinant of unit costs of transportation; these costs increase with distance and decrease with ship size. Whereas freight rate fluctuations of large magnitude are common to the tanker and other bulk-shipping markets, they are rare in other industries. If we are to deal with the economics of oceanborne coal transportation, it is necessary to understand the underlying causes of the erratic behavior of freight rates experienced in coal and other bulk shipping. The variations in bulk freight rate are explained by a ship owner being willing to operate (for the short term) at less than his average variable cost to avoid lay up costs and charging what the traffic will bear if shipping is scarce. Added to this is the great elasticity in shipbuilding but with a three year delay for delivery of large ships. In the short term, the available shipping is inelastic. (LTN)

23547 Overall economics in transportation of coal for export. Shore, M. (Sacramento World Trade Center, West Sacramento, CA). pp 95-102 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

In summary, it is necessary to investigate a large number of alternate transportation combinations that will span the distance from mine to point of consumption. The tendency to accept one feature can fix others that may increase overall cost or even prevent the movement by running into insurmountable environmental obstacles. In reviewing the total cost, the following points should be carefully considered: Select the optimum method for the move from the mine to the land-haul system. Minimize the length of the land haul. The use of sophisticated handling methods is probably a necessity wherever handling is required. Research the possibility of obtaining economies-of-scale in the land haul and port-staging area by incorporating movements and stockpiles for domestic use. Separate the handling costs at both ends of the land haul from the costs per kilometer of distance to be moved. Match the ocean vessel to the size required by the demands of the receiver, considering (a) the interest on the cargo in stockpile, (b) the need to maintain optimum stockpile size to meet the demand and guard against interruptions in the flow from the mine, and (c) the costs of building the receiving and related port facilities. Due consideration should be given to the requirements of environmental demands, the costs of mitigative measures, and the possibilities of complete blockage of the development plan by local environmental demands.

23548 Alternative modes of ocean transportation of coal. Roseman, D.P. (Hydronautics, Inc., Laurel, MD). pp 103-128 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

In the selection of a ship design for ocean transport of coal, the shipowner, operator, and designer work within the constraints of the entire transport system. Consideration of port constraints, load and unload times, and backhaul opportunities directly determine the type, size, and performance of the ship. It is not possible, for example, to select, without qualifications, the preferred configuration for a bulk carrier in coal service, i.e., conventional design, self-unloader, or slurry carrier. Total system study and cost analysis is essential before rational decisions are possible. Finally, it is important to note here the state of the US-flag bulk-carrier fleet available to carry coal or other bulk products. In a June 1977 inventory, the US-flag dry-bulk fleet consisted of only 16 vessels. The total capacity of this US-flag fleet is infinitesimal compared to the total bulk trade in and out of the United States. In 1975, an inventory of all bulk carriers servicing the US international fleet totalled 1039 vessels or approximately one-third the total world fleet, of which seven were US-flag vessels. It is clear from these statistics that one of the alternatives not previously recognized in this paper is the development of a significant US-flag bulk carrier fleet.

23549 Economic considerations of rail and pipeline transportation of coal. Souder, P.S. Jr. (General Research Corp., MeLean, VA); Burt, R. pp 129-149 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

A summary of the major cost for both transportation modes is provided in Table 1. It can be seen that the bulk of the costs associated with rail transportation are operational costs which will be subject to effects of inflation. On the other hand, for pipeline transportation the bulk of the costs are related to the large, front-end investment required to install a pipeline system. Two factors influence the inherent economic characteristics of slurry pipeline transportation. The first is the fundamental fact that volume throughput increases with the square of the diameter of the pipe, and costs increase at a lesser rate. The result is that very significant economies-of-scale are realized as throughput increases. Second, pipeline routes, based on available eminent domain legislation, will be, in most cases, quite direct from origin to destination because each pipeline will be a dedicated system. Given these factors, coal-slurry pipeline transportation will be attractive for long-distance, large-volume coal movements. We have also found that rail transportation of coal can be quite competitive with pipeline transportation even at relatively long distances and large volume levels where rail conditions are considered very good. The problem, however, for the railroads is that these conditions do not exist for many origin-to-destination pairs. The most difficult factor for rail transportation is that of route circuity.

23550 Selected regulatory issues affecting coal transportation requirements. Lippek, H.E. (Lippek and Salwen, Seattle, WA). pp 151-166 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

There are a number of regulatory issues that have a direct impact on coal transportation. In general, waterway transportation is about one-third as expensive as rail transportation, and truck transportation costs are substantially more than rail. The imposition of user charges, even if it only slightly increases the relative cost of water shipment, may, in the longer term, result in a modal shift to other means of transport. Currently, about one-half the coal is moved to consumers by railroad. About one-quarter is moved by water, and a little over ten percent by truck, with the remainder by conveyor, private railroads, and tramways. Coal is the most important single commodity moved by railroads, and, on the average, accounts for about fifteen percent of total railroad revenues. Although the nation's western and southern railroads are in generally sound condition, some railroads in the Northeast and the Midwest have experienced financial problems and have deferred maintenance for decades. The northeast rail system is overbuilt. To protect the financial integrity of the system, large parts of the northeast rail system are now in the process of being abandoned. Abandonment needs to be closely monitored by coal users to ensure that alternative means of delivery are provided as the rail system is streamlined. Another important regulatory issue is the conditions under which coal-slurry pipelines can be constructed.

23551 Comparative costing and capacity measurements: methodological considerations. Rieber, M. (Univ. of Illinois, Urbana-Champaign). pp 167-187 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

Given the renewed emphasis on coal utilization, comparative transport costs play a key role. Misstatement of these costs and of transport prices far in excess of costs yields results that imply a social loss, that may divert potential coal markets to other fields, and that help determine that coal may be produced in the wrong location and may be moved by a cost-inefficient mode. The subject matter is costs, rather than prices. As such, it does not directly correspond to tariffs or rates. The latter may be cost justified, but they include the concepts of rate-of-return, normal profits, monopoly elements, subsidies, sunk costs, and possible distributions of costs from other services. While it is true that consumers pay prices, costs determine competition - the level below which long-run competitive prices cannot fall. Alternatively, a mode with lower costs can, in the absence of long-term contracts, divert sales or service by charging only marginally less than the price of its closest competition. Finally, cost analysis is consistent with both resource allocation and the determination of monopoly profits. As this paper deals with methodology, specific analyses of comparative modal costs are not undertaken. It should be recognized, however, that viable analyses can only be done for consistent origin-destination (O-D) pairs or for

identical destinations from alternative origins. While the analytic effects of differing fuel qualities can be adjusted, volumes must be comparable. Thus, system costs, rather than merely trunk-line costs, are important. The former includes both gathering and distribution systems.

23552 Economics of barge transport of coal. Greene, R.W. (American Commercial Barge Line Co., Jeffersonville, IN). pp 189-201 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

Barging is the safest moving mode of transportation. Barging creates less pollution, less noise, less visual intrusion, and less inconvenience to others. Towboats are freight transportation's most energy-efficient power system. A gallon of fuel will allow a towboat to push over 300 ton-miles. The same gallow of fuel will move about 180 ton-miles in a locomotive, or only 50 ton-miles by truck. A railway tank car requires 1543 pounds of steel per ton of capacity versus 433 pounds for a river barge. It takes 8 man-hours to move 10,000 ton-miles by water, and 14 man-hours to move that amount by rail. The result of these efficiencies is that unit-tows can move coal for 5 to 6 mills per ton-mile compared to unit-train rail rates of 9 to 12 mills. The lowest unit-train rates, by the way, are set in response to water competition, as many current examples show. Although one often hears the argument that rail routes are more direct than circuitous rivers, studies show that actual rail rountings average about 25 percent over the direct route. We find that the rail and the river distances between river points are very similar. Waterways carry about 125 million tons of coal, roughly 20 percent of the nation's production. The waterway share of coal transportation is increasing, and we expect substantial growth in the next decade with the development of new markets in the Gulf and in other areas that have previously burned gas and oil. River transportation is, however, facing a serious problem. It is essentially a political problem. The ability of the waterways to handle the future coal requirements is threatened by the government's failure to modernize and replace outdated locks and dams.

23553 Circuity and the energy-intnsiveness of inland waterway and rail freight transport systems: a progress report. Eastman, S.E. (Economic Science Corp., Washington, DC). pp 203-242 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

The barge (all-water) circuity for the shipment of 10.8 million tons of coal in the TVA model is 1.991. The rail circuity for 14.4 million tons is 1.736. These values have been obtained by taking into account the low and high barge and rail examples noted above, as well as all those in between. For each mode, the estimates are based on the circuity of each of the individual origin-destination pairs - determined by comparison of the actual (modal short-line) distance moved with the hypothetical ideal or straight-line distance, weighted by the amount of traffic or tonnage moving between each origin-destination pair. Rail is 12.8 percent less circuitous than barge [(1.991-1.736)/1.991]. This is far less than the 38 percent that resulted from the earlier study; it is about one-third of that estimate. Moreover, barges provide a substantially less energy-intensive system than railroads.

23554 Great Lakes: a valuable link in the intermodal movement of western coal. Fuller, D.W. (American Steamship Co., New York, NY). pp 263-285 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

Applying the systems approach, and using simplicity as the key, the designer developed the simplest coal-handling system possible to accommodate the systems needs within a controlled environment. Rated at 11,000 net tons per hour, the shiploader has the highest capacity for coal in the world. The underground feed-reclaim system for coal is the world's largest and fastest. The importance of the transshipment facility to the success of the entire intermodal transportation system is critical and cannot be overemphasized. The Superior facility has certainly demonstrated that an effective and efficient transshipment facility is technologically achievable. Geographic placement, stockpiling capacity, multiple-modal access, and multiple-users are all important. Although the coal will arrive by rail at the receiving facility, the modern, multiple-user discharge facility should also be able to offer a variety of transportation modes to accommodate the individual requirements and constraints of each user. The discharge facility should provide access for rail and truck movement as well as docking and loading facilities for smaller class vessels to allow for subsequent inland or Great Lakes coastal movement. The transshipment facility should also incorporate adequate stockpiling capability, given the current limited navigation season on the Great Lakes.

23555 Coal transportation systems performance, a current assessment. Boone, J.W. (Federal Railroad Administration, Washington, DC). pp 287-300 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

It is clear that each of the modes of transportation differs from the others in the manner by which the problem of adequate return-to-capital and labor is addressed in the context of productivity or utilization. I believe that a major source of those differences is the institutional environment surrounding each mode of transportation. The degree and form of economic regulation plays an important part in defining and specifying the responsibility of each mode in a fluctuating coal market. At the same time, the relative capital intensiveness and the economies-of-scale of the respective modes tends to channel the inflow of capital and investment into specific submarkets that offer better prospects for those modes, where utilization and volume directly influence the return-to-capital. Taken together, these forces tand to limit coal pipeline and large-scale water carrier investments to only those submarkets where volume and production assurance are well established. These forces, while they are equally important to coal-carrying railroads, cannot, in many cases, be applied because of the common carrier nature of railroad regulation. To be sure, unit-train operations are an excellent example of economies-of-scale and investment structure. But, for the preponderance of less than train-load and single-car coal shippers, the volume of coal required to institute unit-train services simply does not exist. Yet, smaller shippers attempting to sell in the same marketplace put considerable pressures on railroads to offer coal rates comparable to those available to larger volume shippers. The special problems of volume and spot coal market uncertainties are faced almost exclusively by railroads and will require substantial adjustments in the physical distribution system and in the treatment by regulatory authorities.

23556 Security problems in the rail transportation of coal. Miles, C.V. (Chicago Northwest Transportation Co., IL). pp 301-307 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

Disruptive sabotage can do no more than defer the certainty of the delivery of the coal. This nation has some 200,000 miles of track, and this network of track provides detour facilities to avoid some problem areas, but not all of them. Mine heads and the industrial leads where the coal is being delivered need special protective services. Trains can operate at reduced speeds. We can make inspections ahead of trains to make sure there has been no sabotage on the track. We can confine ourselves to daylight hours for better observation, and we can protect our coal and our train crews. The railroad policeman is experienced in handling disruptive sabotage. It is an everyday problem for him. We have another problem, vandalism. We continually deal with all types of vandalism, and we have had our share of problems with dissident groups in the past, but not of late. The railroad police officer deals with strike-bound plants every day. Somewhere on the railroad system some plant is under strike, and it is being picketed. The pickets are unhappy when we make deliveries or pick up rail cars. Management, after all, continues their operation as best they can, and we are required by law to do our best to serve these industries. The point I am making is that we have the expertise, the experience, and the ability necessary to protect the coal shipments. This brings me to the question of assistance. The railroads do not maintain sufficient forces in their police function to be able to protect their properties during difficule times, as were experienced during the mine worker's strike. It is not economically feasible. During that time, bridges were especially vulnerable. They were a target for arson, and, I might add, an expensive one for the railroads.

23557 Communication requisites to socio-institutional adjustments to technological changes in coal transportation. Sullivan, P.J. (International Longshoreman's Assn., Buffalo, NY). pp 309-319 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

What I am suggesting is that a coordinated, joint effort by industry and labor is desirable, because, basically, we have an education, public relations, and public information problem. The needs, the benefits, and the ways to accomplish the goal of switching from other fossil fuels to coal, and transporting coal in the most economically efficient and environmentally desirable way should be the objective of such an effort. Politically, it is more effective, and I think that community acceptance and cooperation is much more easily accomplished with community input - the old saying, everybody likes a piece of the action. A way to do this is through labor-management committees or task forces composed of people from railroads, utilities, construction firms, terminal operations, and con-

sumer interests. I think that, if the information is disseminated with enough input and a broad enough base, it will make our goals much more easily obtainable.

COMBUSTION

REFER ALSO TO CITATION(S) 23426, 23459, 24012, 24015, 24022, 24023, 24226, 24336, 24427, 24506, 24543

23558 (ANL/CEN/FE—80-1) **Fluidized-bed combustion process evaluation and program support. Quarterly report, October-December 1979.** Johnson, I.; Podolski, W.F.; Henry, R.F.; Hanway, J.E.; Griggs, K.E.; Carls, E.L.; Jonke, A.A. (Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 11p. Dep. NTIS, PC A02/MF A01.

Argonne National Laboratory is undertaking several tasks primarily in support of the pressurized fluidized-bed combustion (PFBC) project management team at Morgantown Energy Technology Center (METC). The Experimental Program Director of the International Energy Agency pressurized fluidized-bed combustion project was selected. Work is under way to provide fluidized-bed combustion process evaluation and program support to METC, including development of a planning methodology for PFBC technology development, determination of the state of the art of instrumentation for FBC applications, and evaluation of the performance capability of cyclones for hot-gas cleaning in PFBC systems.

23559 (CONF-800545—1) **Attrition and elutriation phenomena in industrial atmospheric fluidized bed combustors.** Wells, J.W.; Krishnan, R.P. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From International powder and bulk solids conference and exhibition; Rosemont, IL, USA (13 May 1980).

Attrition and elutriation in large-scale AFBC systems depend on the design of the feed system, bed hydrodynamics and freeboard cooling. At present, no generalized correlation exists to predict these effects. It is suggested that routine solid samples for size analysis be taken before the solids enter the bed. In this way, correlations can be developed to predict the attrition in the feed system and in the bed separately. Secondly, data on the solids loading in the freeboard should be taken and related to bubble size, bubble velocity, bubble frequency and bed expansion. Such information can be obtained in a cold bed for lack of measuring techniques in hot beds. Accurate rate expressions for attrition and elutriation specific to coal ash, limestone, and char can then be developed to predict the performance of AFBC systems.

23560 (DOE/ET/13152—1) **Measuring and modeling solids movement in a large, cold fluidized bed test facility. First quarterly report, 1 October, 31 December 1979.** Fitzgerald, T.J.; Mrazek, R.V.; Crane, S.D. (Oregon State Univ., Corvallis (USA). Dept. of Chemical Engineering). 1979. Contract AC01-79ET13152. 28p. NTIS, PC A03/MF A01.

Descriptions of new and redesigned instrumentation, including a system for direct measurement of solids movement, scaled inductor probes and a pneumatic-release magnetic-collection system are presented. Results of various tests conducted to determine the suitability and feasibility of each instrument as well as a comprehensive literature review are also included.

23561 (FE—1726-34A) **Engineer, design, construct, test and evaluate a pressurized fluidized bed pilot plant using high sulfur coal for production of electric power.** (Dorr-Oliver, Inc., Stamford, CT (USA)). Sep 1977. Contract EX-76-C-01-1726. 124p. (CW-WR—76-015.34A). Dep. NTIS, PC A06/MF A01.

The fluidized bed heat transfer characteristics of vertical finned and unfinned tube heat exchangers were examined in a 12-inch FluoSolids Reactor. Four different heat exchanger tubes were used. The studies were conducted on an isolated U-tube immersed in a fluidized bed combustor burning a high sulfur coal with either dolomite or limestone used as the sulfur sorbent. The unit was operated at atmospheric pressure, 1650°F bed temperature and superficial velocities up to 3.25 fps. The following results were obtained: (1) Very high bed-to-tube heat transfer coefficients, in the range of 118 - 137 Btu/hr ft² °F were obtained with a bare tube using air as a cooling medium. (2) The coefficients with the finned tubes were in the range of 48 - 91 Btu/hr ft² °F. The higher coefficients were obtained on tubes having fewer fins. The highest overall external heat transfer however, was provided by the finned tube having the largest number of fins. (3) The heat transfer coefficients were greatly affected by the mean particle size of the bed material. The coefficient increased as the bed average size decreased. (4) The heat transfer coefficient increased as the fin height decreased, but it did not increase as fast as the heat transfer area decreased. (5) High combustion efficiencies in the 99.6 to 99.8% range were observed and were attributed to the use of a cyclone recycle system and a deep bed. (6) The freeboard dust loading was approximately 350 to 550 grains/ACF with dolomite feed and a cyclone recycle system.

23562 (FE—2304-43) **Treating and feeding SRC to demonstrate its suitability as a gas turbine fuel. Phase II. Final report.** Montgomery, M.E. (Encotech, Inc., Schenectady, NY (USA)). Mar 1980. Contract EX-76-C-01-2304. 54p. NTIS, PC A04/MF A01.

The objective of this investigation was to demonstrate the feasibility of using SRC I as a gas turbine fuel. SRC I was washed with water to reduce sodium and potassium concentrations to levels acceptable to gas turbine manufacturers. The washed SRC I was subsequently burned in a small gas turbine combustion chamber. The washing process consisted of melting the SRC I, mixing it with low pH water to extract the water soluble sodium and potassium, and then allowing the aqueous and fuel phases to separate. This process was carried out at temperatures of about 570°F and pressures of 1300 psig. Wash water in the range of pH 3.5 to 4.0 was used to enhance the removal of fuel bound potassium. This washing technique yielded combined sodium and potassium concentrations of one part per million, a level satisfactory for gas turbine combustion. The washed SRC I was burned in an atmospheric combustion rig which consisted of an air blower, air preheater, and small gas turbine combustion chamber. There was significant coking on the combustor walls. The combustion process was terminated when the fuel nozzle was plugged by coke formation. It is important that the proper materials of construction be selected when handling SRC I. Conventional seal materials in pumps and valves were degraded when they contacted molten SRC I. The requirement of extensive heat tracing, high temperature, high pressures and low pH wash water required careful selection of construction materials. This program has demonstrated the feasibility of burning SRC I in a gas turbine combustion chamber. It is suggested that future work be concentrated in determining pollutant emission concentrations, combustion efficiency, and assessing the combustor modifications required to facilitate clean efficient combustion of SRC I in gas turbines.

23563 **Utilization of solid material containing combustible matter.** Moss, G. US Patent 4,155,313. 22 May 1979. Filed date 15 Jul 1977. 7p.

Solid particles comprising combustible matter (e.g. coal) associated with or contaminated by inert matter (e.g. ash, rock) is segregated in a segregation zone into low density/small size and high density/large size fractions. The low density/small size fractions are passed to a utilization zone for conversion of the combustible matter. The high density/large size fractions are size reduced (e.g. by grinding) and either returned to the segregation zone, or passed at least in part, directly to the utilization zone. The conversion of the combustion matter proceeds more efficiently as a result. The segregation zone may operate by fluidized size/density segregation and in the utilization zone, the combustible matter may be at least partially combusted, preferably in a fluidized bed.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 23536, 23537, 23543, 23544, 23545, 24665

23564 (ANL/EES-TM—84) **Programmer's guide to the Argonne Coal Market Model.** Guziel, K.A.; Krohm, G.C.; VanKuiken, J.C.; Macal, C.M. (Argonne National Lab., IL (USA)). Feb 1980. Contract W-31-109-ENG-38. 109p. Dep. NTIS, PC A06/MF A01.

The Argonne Coal Market Model was developed as part of a comprehensive DOE study of coal-related environmental, health, and safety impacts. The model includes a high degree of regional detail on both supply and demand. Coal demand is input separately for industrial and utility users in each region, and coal supply in each region is characterized by a linearly increasing function relating increments of new mine capacity to the marginal cost of extraction. Rail transportation costs and control technology costs are estimated for each supply-demand link. A quadratic programming algorithm is used to optimize flow patterns for the system. This report documents the model for programmers and users interested in technical details of the computer code.

23565 (METC/SP—79/10(Pt.1), pp 39-44) **Coal and its future.** Holmes, C.D. (National Coal Association, Washington, DC). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

In 1978, preliminary government figures indicate that we have used some 660 million tons of coal for domestic consumption and for export. By far and away the largest single consuming segment of our economy was the electric utility industry which used approximately 480 million tons. Steel coked some 71 million tons and general industrial use accounted for another 61 million tons. Retail dealers sold another 7 million tons and we exported about 40 million. In total, we used less in 1978 than in record 1977, primarily due to the sharp decline in the use of metallurgical coal here and abroad.

1978 use by utilities was approximately 7 million tons greater than in 1977. The use of coal for electric generation was severely affected by the four month UMWA strike which ended last March, by a less than expected growth in demand for electricity, and by a higher rate of utilization of those nuclear plants in areas where nuclear and coal are direct competitors for base load. Coal is America's Ace in the Hole - and its long term future must be one of fairly rapid growth - especially in this century for utility use. The short-term outlook, however, is much less clear and at the current time that outlook rests with our government planners in Washington and not, as it should, with the producers and users of coal in a free market.

23566 (PB—301365) **Quadratic programming and spatial equilibrium: the case of coal. Program working papers.** Yang, C.W. (West Virginia Univ., Morgantown (USA). Dept. of Mineral Economics). Oct 1978. 259p. NTIS, PC A12/MF A01.

The study seeks to theoretically investigate the sensitivities of interregional flow activities of three different approaches in spatial commodity modeling; statistically measure the magnitudes of variations of the decision variables in the T-J model when different parameters are perturbed; and to analyze the path of economic response when the market is in a state of disequilibrium. The L-S and T-J models are carefully evaluated. Seven demand and supply equations employed in testing the T-J model are derived by the step function method. A set of efficient solutions is used to measure the performance of the steam coal industry, which indicates the possibilities of considerable dominances of consumers' surpluses over rents. The paradoxes discussed indicate the fact that regional economic responses are determined to a large extent by interregional flow activities.

23567 **Western coal project.** Tauber, H. (Detroit Edison, MI). pp 243-261 of Critical issues in coal transportation systems. Washington, DC; National Academy of Sciences (1979).

From Symposium on critical issues in coal transportation systems; Washington, DC, USA (14 Jun 1978).

We at Detroit Edison have been evaluating our position between coal, nuclear power, and other energy alternatives. We beleive that coal and nuclear power are the only way to go. In fact, there is no alternative to nuclear power, even if you triple the coal industry by the year 2000 - something that I think is almost impossible to do, from both a production and a transportation standpoint. So, we made our decision to go with coal and nuclear. Then, we were faced with the need to make a decision about our new coal plants, in light of the new regulations concerning sulfur oxide emissions. We had to decide whether to go to the West for low-sulfur coal, to to the East for low-sulfur coal, or take high-sulfur coal and scrub it. Now, the Environmental Protection Agency has come up with a regulation called Best Available Control Technology that says you shall scrub coal no matter what its sulfur content. We think that the union conditions and the transportation network we have now established are such that going West is a logical move for us with new power plants. However, our strategy is that, wherever we convert existing plants to low-sulfur coal, we will use eastern coal for a number of reasons. First, because the burning properties of eastern coal are far superior to western coal. Also, because eastern coal is 12,000 to 13,000 Btu per pound, instead of 9600 Btu per pound of the western coal. Although the western coal has a lower sulfur content, it also has sodium in the ash. That sodium causes difficult fouling problems. Unless we design the plant specifically for western coal, it is a very difficult thing to use.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 23524, 24765

23568 (PB—300365) **Sideboard device for improved face ventilation in coal mines. Technical progress report.** Drivers, E.F.; LaScola, J.C.; Kissell, F.N. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Mining and Safety Research Center). Aug 1979. 13p. NTIS, PC A02/MF A01.

The Bureau of Mines recently tested a sideboard device that is designed to act as an extension of conventional brattice, thus improving face ventilation of developing room-and-pillar-type coal mining. In these laboratory tests, an 8-foot-long rigid sideboard was mounted vertically along the left fender of a full-scale-model ripper-type continuous mining machine, rising to the mine roof to provide an air seal. It extended from the auger support frame pivot point outby along the fender. A novel water spray manifold was used to form an air seal between the sideboard and brattice. Tests showed improvement in face ventilation with the prototype device, and also demonstrated that water sprays can form an effective air seal over a fairly wide pressure range. Based on this preliminary study, subsequent improvements may make the sideboard concept much more effective, thus affording a simple, inexpensive technique to improve the effectiveness of face ventilation.

23569 (PB—300724) **The application of advanced mine air monitoring techniques to mines using diesel powered equipment. Annual report no. 2, January 1977-June 1978.** Johnson, J.H.; Carlson, D.J.; Bunting, B.G. (Michigan Technological Univ., Houghton (USA)). Jun 1978. Contract G0166027. 311p. NTIS, PC A14/MF A01.

Reseach is being directed toward developing optimum methodology to control air quality in underground mines where diesel equipment is employed at the working face. Emphasis is primarily on instruments, measurement techniques, and field ambient concentration data. Mine evaluation of vehicle mounted CO2 monitoring prototypes and the development of a recording system that stores the CO2 data in the form of a cumulative frequency distribution are described. CO, CO2, NO, NO2, and particulate matter measurements near diesel equipment in Colorado Westmorelands' Orchard Valley mine are reported. Evaluations of the NO2 sampler, the particulate matter nonitors, the oxides of nitrogen monitor, bag sampling for CO2, the NO2 prototypes, and the hi-flow samplers are discussed. The state-of-development of the mine air monitoring laboratory (MAML) and examples of its use are included. A punch tape data system, a thermocouple system, a fire extinguisher system, capability for 10 gaseous sample lines, and two particulate sample lines with a 10:1 dilution system have been added to the MAML.

23570 **Face ventilation system for coal mines.** Kissell, F.N.; Matta, J.E. US Patent 4,157,204. 5 Jun 1979. Filed date 27 Jul 1978. 5p.

A coal mine ventilation system which is described insures proper ventilation near the working area. The basis system employs a mining machine on which is mounted a panel on a movable frame, a conventional line curtain fixed to the mine floor and roof and located adjacent to the panel, and an air control fluid spray system. Fluid sprays may be mounted on the machine opposite the panel to promote airflow towards the mining face. Additional sprays may be mounted on the machine panel to provide an effective barrier between that panel and the fixed line curtain.

REGULATIONS

REFER ALSO TO CITATION(S) 23531, 23557

23571 **Mining reclamation laws.** Haynes, R.; McBrayer, J. *Oak Ridge Natl. Lab. Rev.;* **12**: No. 4, 22-27(Fal 1979).

The impact of the Surface Mining Control and Reclamation Act of 1977 on mining in southern Appalachia is discussed. Previous Tennessee surface mining regulations had not provided for elimination of all highwalls nor for some dumping of spoil materials downslope. The new act and the permanent regulations now define special environmental standards for mining steep slopes. State-of-the-art measures are demanded to prevent acid-mine drainage that could adversely affect surface and underground waters. Reclamation of mines abandoned before reclamation was required will be financed by a tax on new coal. The law also provides for designation of areas as unsuitable for all types of coal mining. A recent meeting of the Americal Council for Reclamation Research identified specific research and assessment needs in the study of coal extraction and reclamation. (SAC)

PETROLEUM

RESERVES

23572 (CONF-791241—1) **Limiting behavior of sampling proportional to random size.** Uppuluri, V.R.R.; Patil, S.A. (Union Carbide Corp., Oak Ridge, TN (USA). Computer Sciences Div.; Tennessee Technological Univ., Cookeville (USA). Dept. of Mathematics). 1979. Contract W-7405-ENG-26. 2p. NTIS, PC A02/MF A01.

From 42. session of the International Statistical Institute; Manila, Philippines (4 Dec 1979).

Let $X_1, X_2, \ldots, X_N$ be N nonnegative i.i.d. random variables. Let $Y_1 = X_\alpha$ with probability $X_\alpha/(X_1 + \ldots + X_N)$, $\alpha = 1,2\ldots,N$. This is referred to as the first realization when sampling with probability proportional to random size. Next Y_1 is deleted from $X_1, X_2, \ldots, X_N$ and another observation Y_2 is made similarly. Thus, in sampling proportional to random size, without replacement, one can obtain the sequence $Y_1, Y_2, \ldots, Y_n$. Let f(x) and μ denote the probability density function (pdf) and mean of X_α, respectively. The pdf of the associated length-biased variable Y of X is defined by $yf(y)/\mu$. It is shown that, as N tends to infinity, Y_1 behaves like the length-biased sample of X. In a second theorem it is shown that, as N tends to infinity, $Y_1, Y_2, \ldots, Y_n$ behaves like independent length-biased variables of X.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 24571, 24974

23573 (DOE/BC/20006—14) **Single-well chemical tracer test simulator handbook: improved accuracy and interpretation for residual oil saturation measurement.** Deans, H.A.; Majoros, S. (Rice Univ., Houston, TX (USA)). Apr 1980. Contract AS19-79BC20006. 54p. Dep. NTIS, PC A04/MF A01.

The single-well test is an experimental field procedure for determining residual oil saturation (S/sub or/). Unfortunately an analytical solution is available only for an ideal test and any real-world complication makes an analytical solution virtually impossible. In this case, however, a determination of S/sub or/ can be made by a computer simulation of the fluid flow through the test formation. The program TRACRL accomplishes this. This handbook gives the mathematical basis for the simulator and a description of the input and output formats. Two sample problems are described and full documentation is provided in the appendices.

23574 Michigan's Silurian oil and gas pools. Report of investigation 2. Ells, G.D. Lansing, MI; Michigan Department of Natural Resources (1978). 54p. (NP—24381). Michigan Dept. of Natural Resources, Information Services Center, Lansing, MI, $2.00.

Silurian rocks are an increasingly important source of oil and gas in the Michigan Basin. Most Silurian pools found to date are around the southern edge of the basin in the southwestern and southeastern part of the state. Many Devonian structures around the edge of the basin and in the interior are yet to be tested and may eventually yield Silurian hydrocarbons. Reservoir rocks are reefs and porous, dolomitized intervals of carbonate formations. Oil and gas traps in the latter are often localized on synchronous structures related to underlying reefs or small salt-cored anticlines. Silurian reefs and salt structures are often reflected by structural closures in formations as young as Mississippian. Reefs and synchronous structures are discussed and figured. Silurian subsurface nomenclature used in oil and gas exploration differs from the formal nomenclature established by outcrop studies. A variety of terms are used. Correlations are based mainly on mechanical log curve characteristics. Terminology is discussed and related to log cross sections and other illustrations. General pool or field data, production, gas analysis, and some reservoir data are presented.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 24444

23575 (DOE/BC/10069—6) **Mechanism of oil bank formation, coalescence in porous media and emulsion stability. Annual report, June 1978-May 1979.** Wasan, D.T. (Illinois Inst. of Tech., Chicago (USA)). May 1980. Contract AC19-79BC10069. 110p. Dep. NTIS, PC A06/MF A01.

This report summarizes results of a basic study of coalescence phenomena, emulsion formation and stability, and dynamic interfacial properties when crude oils are contacted with aqueous solutions of surfactant/polymer and alkaline agents. These measurements are correlated with each other and with oil displacement efficiency by chemical flooding in laboratory experiments. Crude oils from Salem, Loudon, Huntington Beach and Wilmington fields, and two pure hydrocarbons, namely n-octane and n-dodecane, were used in the present study. The six chemical recovery agents employed were Petrostep 420, TRS 10-80, TRS 10-410, orthoxylene sulfonate, sodium hydroxide and sodium orthosilicate. 45 figures, 6 tables.

23576 (DOE/BETC—80/1) **Contracts for field projects and supporting research on enhanced oil recovery and improved drilling technology. Progress review No. 21, quarter ending December 31, 1979.** Linville, B. (ed.). (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). Apr 1980. 145p. NTIS, PC A07/MF A01.

Individual report are presented of contracts for field projects and supporting research on chemical flooding, CO_2 injection, thermal/heavy oil, resource assessment technology, improved drilling technology, residual oil, environment, and petroleum technology. (DLC)

23577 (DOE/BETC/5785—1) **Carbon dioxide for the recovery of crude oil: a literature search to June 30, 1979. Final reportp.** Doscher, T.; Rebert, C.; Ershagi, I.; Omerogie, O.; Azari, M.; Bazshushtari, A.; Gharib, S.; Marinello, S. (University of Southern California, Los Angeles (USA). Dept. of Petroleum Engineering). May 1980. 501p. Dep. NTIS, PC A22/MF A01.

Individual summaries and pertinent commentaries on each of the groups of references into which the literature on carbon dioxide for the recovery of crude oil has been classified are presented in this report. The major classifications are: physical models, laboratory studies, field tests, modelling, patents, and miscellaneous. A special summary that reviews and comments on field operations, fluid handling, and corrosion problems is also included. User's guide and subject categories for the CO_2 literature survey are given, followed by abstracts of the citations. It is concluded from this survey that the most significant deficiency in research on carbon dioxide flooding for the recovery crude oil is the paucity of well controlled and interpreted field tests.

23578 (DOE/BETC/RI—80/3) **Precipitation of petroleum sulfonates by magnesium ions.** French, T.R.; Collins, A.G. (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). May 1980. 17p. Dep. NTIS, PC A02/MF A01.

The precipitation of petroleum sulfonates was accomplished by the addition of magnesium ions. The magnesium tolerance, defined as the total magnesium concentration at which 5% of the total sulfonate was precipitated, was determined in aqueous solution for 20 commercial petroleum sulfonates. The magnesium tolerances ranged from essentially zero up to 2300 ppM of magnesium. The level of magnesium tolerated increases as the average equivalent weight of the sulfonate decreases. The precipitate formed during the reaction includes a high percentage of sodium sulfonate as well as magnesium sulfonate. All of the samples were prepared to contain 3% active sulfonate, and the reaction temperature was 30°C. The precipitate was removed by centrifuging and filtering. The amount of unreacted sulfonate remaining in the filtrate was determined indirectly by measuring the magnesium and sodium remaining in the filtrate. The viscosities of the filtrates were found to change as the amount of magnesium added was increased. The viscosity goes through at least one maximum before rapid precipitation of sulfonate occurs. 5 figures, 2 tables.

23579 (DOE/MC/03259—6) **Enhanced oil recovery by CO_2 foam flooding. First annual report.** (New Mexico State Univ., Las Cruces (USA). Dept. of Chemical Engineering). Feb 1980. Contract AC21-78MC03259. 81p. NTIS, PC A04/MF A01.

An extensive review of the literature revealed that the use of foam to lower the mobility of gases used to displace oil has been considered since 1956. Although early work was related mainly to light hydrocarbons, it is natural to extend the concept to the CO_2 flooding process. Samples of foaming agents, compatible with oil reservoir environments, were obtained from major manufacturers. Ninety-three samples were tested both alone and in admixture. The most promising class of additives appears to be ionic surfactants produced by ethoxylation of a linear alcohol followed by sulfation. One of the best, Plurafoam NO-2N was tested in a linear sandpack and found to reduce the mobility of gas relative to water an average of 300-fold. Viscosity measurements of the foam at varying shear rates were made to help explain the dramatic change in gas mobility in the linear flow model. The foam is non-Newtonian but many-fold more viscous than the liquid from which it is generated at all reasonable shear rates. Viscosities exceeding 1000 centipose are routinely obtained. Addition of water-soluble polymers to the foaming liquid greatly enhances the stability of the foam. Five different polymer structures were tested, all of which had a common cellulosic type backbone. Of this group, hydroxypropyl cellulose and zanthan gum appear to be the most promising candidates. The superiority of these polymers lies primarily in their stability at reservoir conditions in the acid environment created when carbon dioxide dissolves in water.

23580 Aqueous drilling fluid and lubricant composition. Elrod, S.H.; Nance, W.B. (to Milchem Inc.). US Patent 4,181,617. 1 Jan 1980. Filed date 13 Feb 1978. 6p.

An aqueous drilling fluid is provided having a lubricant consisting essentially of the reaction product of a fatty vegetable oil with 4,4′-thiodiphenol. 10 claims.

23581 Oil-production platform and method of assembling and installing the same on a sea bed. Pagezy, M.J.; Loire, R. (to Entreprise d'Equipments Mecaniques et Hydrauliques E.M.H.). US Patent 4,181,452. 1 Jan 1980. Priority date 2 May 1977, France, 6p.

The invention relates to a method of assembling and installing a device for exploiting an oil-field. Said device comprises an upper structure comprising two superposed platforms provided with a vertically slidable column, and a lower structure comprising at least two tanks connected to the upper structure by means of support legs. Such a device allows its elements i.e. each of the platforms and the tanks to be fabricated separately, and the assembly to be performed only in floating conditions and not in a dry dock. Furthermore the fabrication can therefore take place in a yard designed for constructions of small size compared with that of the completely assembled device. 8 claims.

23582 Method and apparatus for recovery of subsea well equipment. Darby, L.B.; Holley, J.A. (to Exxon Production Research Co.). US Patent 4,181,196. 1 Jan 1980. Filed date 23 Jun 1977. 4p.

Method and apparatus are disclosed for recovering submerged equipment, such as a guide base and wellhead used in

offshore well operations. A recovery tool, which includes an elongated member capable of extending from above the equipment into a well pipe and means for latching the recovery tool to the equipment and explosive means attached to the elongated member for severing the well pipe, is lowered from the water's surface to the equipment and then latched thereto. The explosive is then detonated to sever the well pipe. The recovery tool, together with the equipment and severed portion of the well pipe, is raised to the water's surface.

23583 Oil recovery by waterflooding with thickened surfactant solutions. Savins, J.G. (to Mobil Oil Corp.). US Patent 4,181,178. 1 Jan 1980. Filed date 12 Dec 1977. 12p.

Waterflooding process is described for the recovery of oil for a subterranean formation in which at least a portion of the injected water is thickened by the addition of a sulfonated polyethoxylated aliphatic alcohol surfactant. The thickened water has a salinity within the range of 5 to 18 percent. The sulfonated polyethoxylated aliphatic alcohol has at least two ethylene oxide units to provide an HLB within the range of 10.0 to 14.0 and the lipophilic base contains from 16 to 20 carbon atoms. The thickened surfactant slug may be preceded by the injection of a relatively low viscosity surfactant slug and viscosity gradation of the thickened surfactant slug may be accomplished by varying the salinity and/or the concentration of the sulfonated polyethoxylated aliphatic alcohol.

23584 Shock absorber for oil well pumping unit. Case, R.W. (to K-Shox, Inc.). US Patent 4,176,714. 4 Dec 1979. Filed date 15 Jun 1978. 4p.

A shock absorber for use to interconnect the polish rod of an oil well with the pumping unit in which the pumping unit includes a hanger bar having an opening therein receiving the polish rod is described. The shock absorber employs a tubular body axially to receive the polish rod. This tubular body is supported on the hanger bar and includes a number of disc of elastomeric material. Each disc has an opening therein and includes a top plate secured to the polish rod with a polish rod clamp so that on up stroke of the pumping unit the elastomeric members are pressed and the openings therein form an air cushion to assist in alleviating shock transition from the polish rod to the pumping unit. 2 claims.

23585 Subfloor for offshore production platform. Phaup, C.W.; Lower, J.D. (to JBC Enterprises, Inc.). US Patent 4,175,889. 27 Nov 1979. Filed date 12 Jun 1978. 8p.

An improved subfloor for offshore production platforms is described. The subfloor comprises leg-supported modules and drop in panels adapted to be installed around a grid of Christmas trees in the well bay area. The arrangement facilitates access to Christmas trees in the well bay area intermediate the cellar deck and main deck of the platform.

23586 Method for monioring fluid movement behind casing in oil and gas wells. Fertl, W.H. (to Dresser Industries, Inc.). US Patent 4,173,718. 6 Nov 1979. Filed date 2 Sep 1977. 4p.

Well is first logged with gamma ray detection system to provide a base log. Fluid containing salt of potassium, uranium or thorium is then injected into the well opposite the interval of interest. When the well head pressure is increased, some of the injected fluid will move into the channel which is allowing fluid to move between different zones in the formations around the well. The gamma ray detection system is then again run through the well to provide a log which is compared with the base log. The channel between zones is detected by localized drastically higher readings observed on the repeat run of the gamma ray detection logging system.

23587 Method for removing suspended oil droplets from water. Williams, R.E. (to Exxon Production Research Co.). US Patent 4,173,533. 6 Nov 1979. Filed date 7 Nov 1977. 8p.

Suspended droplets of oil are separated from a waste water stream by the method and apparatus of the present invention. The oil and water mixture is injected into a partially submerged, vertical pipe. Gas bubbles injected into the lower end of the pipe, rise through the pipe and counter-currently contact the suspended oil droplets thereby promoting the separation of the droplets from the waste water. The oil droplets coalesce and form a separate oil layer on top of the waste water which is readily withdrawn while clarified waste water is discharged from the lower end of the pipe. If employed to separate oil from a waste water stream on an offshore rig, the vertical pipe is submerged adjacent to the rig.

23588 Lignosulfonates carboxylated with cloroacetic acid as additives in oil recovery processes involving chemical recovery agents. Kalfoglou, G. (to Texaco Inc.). US Patent 4,172,497. 30 Oct 1979. Filed date 17 Apr 1978. 14p.

A process for producing petroleum from subterranean formations is disclosed wherein production from the formation is obtained by driving a fluid from an injection well to a production well. The process involves injecting via the injection well into the formation an aqueous solution of lignosulfonate salt carboxylated with chloroacetic acid as a sacrificial agent to inhibit the deposition of surfactant and/or polymer on the reservoir matrix. The process may best be carried out by injecting the lignosulfonates carboxylated with chloroacetic acid into the formation through the injection well mixed with either a polymer, a surfactant solution and/or a micellar dispersion. This mixture would then be followed by a drive fluid such as water to push the chemicals to the production well.

PROCESSING

23589 Production of lubricants. Bailly-Lacresse, J.G.; Bonzom, A.; Courtois, J.C. (to British Petroleum Co.). US Patent 4,181,595. 1 Jan 1980. Priority date 24 Jan 1977, France, 6p.

Platinum on a largely SiO_2 catalyst is used for dearomatization of light lubricating oils. The catalyst can successfully process feedstocks with sulphur contents as high as 100 to 3000 ppM. 10 claims.

23590 Process for regenerating metal-contaminated hydrocarbon conversion catalysts. Luckenbach, E.C. (to Exxon Research and Engineering Co.). US Patent 4,176,084. 27 Nov 1979. Filed date 11 Nov 1977. 8p.

Hydrocarbon conversion catalysts which have become deactivated by the deposition of coke and metal contaminants such as nickel, iron, vanadium, etc., are regenerated under conditions which include temperatures in excess of 1300°F and the periodic use of an amount of oxygen which is in excess of that required to completely burn the coke to CO_2. The periodic use of an excess and a deficit of O_2 at the relatively high temperatures serves to reduce the poisoning effect of the metals deposited on the catalyst and eliminate the need for a continuous supply of large quantities of O_2. The process is applicable to zeolite type catalysts.

23591 Apparatus and method for controlling the rate of feeding a petroleum product to a coking drum system. Bruce, C.R.; Johnson, I.D.; McGrievy, L.H. (to Marathon Oil Co.). US Patent 4,176,052. 27 Nov 1979. Filed date 13 Oct 1978. 12p.

A coking drum system is provided in combination with a process control unit wherein the rate of material delivered to a coking drum during a coking process timing cycle is monitored and the quantity of material received by the coking drum is continuously derived therefrom. Based on this derived quantity of delivered material, the quantity of feed material required to fill the drum to a preestablished level with coke, at the completion of the timing cycle can be predicted. The flow rate of feed material to the coking drum is accordingly adjusted so that the amount of coke produced in the drum during one timing cycle is optimized.

23592 Method of producing petroleum coke calcinate. Dudek, M; Tieke, O. (to Wintershall Aktiengesellschaft). US Patent Patent 4,176,010. 27 Nov 1979. Priority date 28 Jul 1976, German, Federal Republic of (F.R. Germany), 10p.

Green petroleum coke is indirectly dried, then calcined in a cylindric rotary kiln and indirectly cooled utilizing a one-way gas flow in the system. Most of the dust in the vapor from the drying step is directly burned in a steam boiler whose off-gases are used to heat the dryer. Any residual dust in the gas is collected in an electrofilter. This dust together with dust which settles out from the dryer and the kiln is collected and added in controlled amounts to the dried coke before calcining. Hydrocarbons expelled during calcining are partially burned off with a stream of secondary air introduced at the coke exit end of the kiln. Most of the remaining hydrocarbons are burned off before they leave the coke inlet end of the kiln. The calcined coke product contains 0.1% by weight of hydrocarbons. The final off-gas from the process has a residual dust content of less than 100 mg/nm^3.

23593 Hydroprocessing of hydrocarbons over nickel, moly, platinum catalyst. Hilfman, L. (to UOP Inc.). US Patent 4,175,033. 20 Nov 1979. Filed date 18 Dec 1978. 22p.

The invention involves the hydroprocessing of hydrocarbons and mixtures of hydrocarbons, utilizing a particular catalytic composite. This catalyst comprises a porous zeolitic carrier material combined with a platinum component, a nickel component, and a molybdenum component; in many applications, the catalytic catalytic composite will also contain a halogen component, and in some select applications, and alkali metal or alkaline-earth component. Hydrocarbon hydroprocesses are hydrocracking, the hydrogenation of aromatic nuclei, the ring-opening of cyclic hydrocarbons, desulfurization, denitrification.

23594 Hydrotreating of pyrolysis gasoline. Bauer, W.V. (to Lummus Co.). US Patent 4,173,529. 6 Nov 1979. Filed date 30 May 1978. 4p.

In the catalytic hydrotreating of pyrolysis gasoline, the major portion of dienes present in the hydrotrented product concentrate in the C_6 fraction. The C_6 fraction is separated from a first portion of

the hydrotreated effluent and a portion of the separated C_6 fraction is combined with a second portion of the hydrotreated effluent as a combined recycle stream to the hydrotreating reaction. By combining a portion of the separated C_6 fraction with the recycle hydrotreated effluent, the net C_6 product recovered from the process has a diene value which is lower than that which would be obtained without the C_6 recycle.

23595 Slurry hydrogen treating processes. Allan, D.E.; Lewis, W.E.; Metrailer, W.J. (to Exxon Research and Engineering Co.). US Patent 4,137,149. 30 Jan 1979. Filed date 29 Jun 1977. 4p.

The liquid product of a slurry hydrogen treating zone is separated into fractions in the same separation zone used to obtain the heavy hydrocarbonaceous oil fraction used as feed for the hydrogen treating zone. A separate portion of coarser solids is withdrawn from the hydrogen treating zone.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 23589

23596 Grafted copolymers and their use as additives for lubricating oils. Durand, J.P.; Gateau, P.; Dawans, F.; Chauvel, B. (to Institut Francais du Petrole). US Patent 4,181,618. 1 Jan 1980. Filed date 30 Jan 1978. 10p.

Graft copolymer is formed by reacting at least one polymerizable vinyl compound, in monomeric or polymerized form, with a hydrogenated polymer or copolymer selected from the hydrogenated homopolymers of conjugated dienes of 4-6 carbon atoms, the hydrogenated copolymers of at least 2 conjugated dienes and the hydrogenated copolymers of styrene and conjuated dienes of 4-6 carbon atoms, said hydrogenated polymer or copolymer having an average molecular weight ranging from 10,000 to 300,000 and a residual olefinic unsaturation lower than 15%. 12 claims.

23597 Method of stabilizing lube oils. Yan, T.Y.; Bridger, R.F. (to Mobil Oil Corp.). US Patent 4,181,597. 1 Jan 1980. Filed date 1 May 1978. 12p.

A process is provided for improving the stability of a hydrocarbon mineral oil, particularly a hydrocracked stock, normally susceptible to thermal oxidation and the effect of light rays and for decreasing the tendency of the oil to form sludge material. The process involves reacting the hydrocarbon mineral oil before or after conventional treatment, such as dewaxing operations, with a stabilizing agent, such as an olefin, alcohol, ester or alkyl halide in the presence of a heterogeneous acidic catalyst which includes acid resins, clays and aluminosilicates, and which has a controlled alkylation activity. The final oil product has improved light stability over a conventionally treated oil. 11 claims.

23598 High severity process for the production of aromatic hydrocarbons. Mayes, W.W. (to Cosden Technology, Inc.). US Patent 4,174,270. 13 Nov 1979. Filed date 3 Nov 1977. 14p.

Disclosed is a process for the production of highly aromatic reformates, having a minimum of noaromatic material, in high yield from a naphtha feed fraction by high-severity catalytic reforming, using a halogen-promoted reforming catalyst. The process comprises reforming the naphtha feed under reforming conditions of high severity in a plurality of sequentially arranged reaction zones in which the concentration of the halogen component of the reforming catalyst is adjusted to provide a minimal hydrocracking activity relative to the other reforming reactions to the catalyst in the first reaction zones, and an enhanced hydrocracking activity to the catalyst in the last reaction zones. The reformates produced according to this process are particularly ueful in the blending of high aromatic content gasolines and/or in the production of high purity aromatic hydrocarbons.

23599 Fire-safe hydrocarbon fuels. Fodor, G.E.; Weatherford, W.D. Jr.; Wright, B.R. (to Secretary of the Army). US Patent 4,173,455. 6 Nov 1979. Filed date 11 Oct 1978. 6p.

A stabilized, fire-safe, aqueous hydrocarbon fuel emulsion prepared by mixing: a diesel fuel; an emulsifier (consisting of oleyl diethanolamide, diethanolamine, and diethanolamine soap of oleic acid) which has been treated with about 0 to 7 1/2 of oleic acid. A modified version of this fuel also contains 0 to 0.5% of an antimisting agent, and water.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 24207

23600 (DOE/PE—0019(Vol.1)) State of competition in gasoline marketing. The effects of refiner operation at retail (a study required by Title III of the Petroleum Marketing Practices Act). Delaney, J.B.; Fenili, R.N. . (Department of Energy, Washington, DC (USA). Assistant Secretary for Policy and Evaluation). May 1980. 221p. Dep. NTIS, PC A10/MF A01.

Title III of the Petroleum Marketing Practices Act requires the Secretary of Energy to report to the Congress on the extent to which producers, refiners, and other suppliers of motor fuel subsidize the sale of such fuel at retail or wholesale with profits obtained from other operations. This is Part I of the report required under that Title. It addresses a number of questions relating to the central issue - the state of competition in the gasoline marketing industry. Part II of the report, to be issued this fall, will discuss the subpoenaed documents of nine integrated companies, and will contain recommendations for action, if deemed necessary. The basic thrust of Part I is an examination of three issues: (1) Are integrated refiners subsidizing their company operated gasoline retail outlets; (2) Are integrated refiners moving gasoline away from their branded dealer network into their own retail outlets; and (3) Are integrated refiners manipulating the allocation system in favor of their own retail outlets to the detriment of other gasoline marketers. At a series of regional hearings, independent marketers charged that integrated refiners were engaging in each of these practices. In essence, integrated refiners were portrayed as using unfair or illegal competitive practices which would ultimately lead to their domination of retail gasoline markets. This report addresses each allegation, after providing a historical and theoretical framework for today's debate.

23601 (LA—8347-MS) Modeling the number of bids received on federal offshore hydrocarbon leases by poisson-type models. Nachtsheim, C.J.; Bruckner, L.A. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 20p. NTIS, PC A02/MF A01.

Since 1954, the federal government has held over 40 hydrocarbon lease sales on the Outer Continental Shelf. A maximum of 18 sealed bonus bids was received for each of the tracts offered. A mixed Poisson-type model has been suggested for the relative frequencies of the number of bids received by an offered tract. Here we show that statistically this model may only be supportable for the number of solo bids received in sales after the Joint-Bidding Ban of 1975. A truncated model (excluding tracts receiving no bids) is proposed. While an improvement results from the use of this model, it appears that models of the mixed Poisson-type may not be generally applicable to the number of bids data.

23602 (PB—300697) Alaska OCS Socioeconomic Studies Program. Technical rept. No. 38. Western Gulf of Alaska petroleum development scenarios: economic and demographic impacts. (Alaska Univ., Anchorage (USA). Inst. of Social and Economic Research). Aug 1978. Contract DI-AA550-CT6-61. 379p. NTIS, PC A17/MF A01.

The study is part of the Bureau of Land Management's Alaska OCS Socioeconomic Studies Program. The objective of this program is to assess the potential impacts of proposed lease sales in the federal offshore areas of Alaska. The study of the impacts of ICS development in the WEstern Gulf of Alaska is one of a series of studies describing lease sale impacts. Already completed is a study of the impact of the joint federal-state sale in the Beaufort Sea (ISER, 1978) and the federal sale in the Northern Gulf (ISER, 1979); future studies will be conducted for lease sales in the Lower Cook Inlet and the Bering Sea-Norton Sound. The studies program is concerned with many aspects of OCS impact on many different levels. The major objective of this study is to examine only a portion of OCS impact, the statewide and regional economic and demographic impacts. In order to assess the impact of the proposed Western Gulf OCS development, the study accomplishes two additional objectives. First, an understanding of the existing state and regional economies is developed. The important economic relationships need to be understood in order to say anything about future growth and the effect of OCS development on the economy. Secondly, the study develops a process for economic impact assessment. Rapid growth associated with OCS development will affect most economic variables; a much smaller number is important, and information on these dimensions of impact will describe the effect of rapid growth on the state and regional economies. The process of economic impact assessment consists of the selection of the major variables to analyze and the appropriate questions to ask about each of these.

23603 (PB—300699) Alaska OCS socioeconomic studies program. Technical report No. 36. Northern Gulf of Alaska petroleum development scenarios: sociocultural impacts. Bennett, M.E.; Heasley, S.D.; Huey, S. (Dames and Moore, Anchorage, AK (USA)). 30 Aug 1979. Contract DI-AA550-CT6-61. 302p. NTIS, PC A14/MF A01.

The report concerns the sociocultural systems of two towns within the arc of the Northern Gulf of Alaska--Cordova-Eyak and Seward. Its purpose is to provide both a methodology and a detailed community-based information base about these towns within the context of the broader objectives of the Alaska OCS Socioeconomic Studies Program. As one of several studies aimed at assessing the effects of Alaska OCS Petroleum Development upon the physical, social and economic environment of the Northern Gulf lease sale

area, this study analyzes the social organization, social conflict, social change and recent events occurring within these two towns. In addition, it attempts to place these two towns and the effects of Alaska OCS Petroleum Development on them within a regional context while still maintaining a town focus. Attention is thereby drawn to the response capacity of the social system of these two towns to adapt to changes which have already occurred recently or are likely to occur in the near future.

23604 (PB—300701) **Alaska OCS socioeconomic studies program. Technical report No. 43. Lower Cook Inlet and Shelikof Strait petroleum development scenarios. Final report.** (Dames and Moore, Anchorage, AK (USA)). Jul 1979. Contract DI-AA550-CT6-61. 266p. NTIS, PC A12/MF A01.

In order to analyze the socioeconomic and environmental impacts of Lower Cook Inlet and Shelikof Strait petroleum exploration, development, and production, it is necessary to make reasonable and representative predictions of the nature of that development. The primary purpose of this report is, therefore, to describe in detail a set of petroleum development scenarios that are economically and technically feasible, based upon available estimates of oil and gas resources of the Lower Cook Inlet and Shelikof Strait.

23605 Historic and projected oil and gas consumption. O'Connor, K.; Montbriand, R. Anchorage, AK; Department of Natural Resources (1979). 22p. (NP—24405).

The oil and gas consumption analysis for 1977 and 1978 is presented to update the 1978 report entitled Oil and Gas Consumption in Alaska: 1976 to 2000. Data for all consumption categories are provided for 1977, and transportation fuels and natural gas statistics are presented. The amount of fuel consumed for power generation and heating uses has not yet been tabulated by the Department of Energy, the primary source for petroleum liquids data. Natural gas consumption continues to increase, in 1977 by 36.7% and in 1978 by 18.9%. Gas consumption for power generation in 1977 increased by 10.2% and virtually remained constant through 1978. Residential/Commercial Consumption increased by 11.3% and 9.6% for the respective years. Industrial consumption grew by 60% in 1977 and 28.2% in 1978, with the greatest increase occurring in the amount of natural gas consumed during petroleum production. Petroleum liquids consumption decreased by 6.1% from 1976 to 1977. Declines occurred in each major category. Consumption of oil products for power generation decreased by 12.5%, heating by 0.2% and transportation fuels by 6.5%. Transportation fuels experienced mixed gains and losses with marine gasoline consumption increasing by 8.5%, marine diesel by 24%; aviation gasoline increasing by 21.7% and jet fuel decreasing by 6.8%; highway gasoline showed an increase of 1.8% and diesel decreased by 22.6%. In 1978, transportation fuels consumption decreased by 2.9%. Marine gasoline increased by 18.8%, marine diesel grew by 13%. Aviation gasoline decreased by 10.1% while jet fuel increased by 1.5%. Highway gasoline and diesel decreased by 7.4% and 2.9%, respectively.

WASTE MANAGEMENT

23606 Method of transporting liquid pitch containing lumpy cokes and apparatus therefor. Kawabe, N.; Kaji, H.; Miwa, N.; Nakanishi, H.; Tanaka, F.; Inoue, T. (to Kureha Kagaku Kogyo Kabushiki Kaisha). US Patent 4,175,708. 27 Nov 1979. Priority date 27 Jan 1977, Japan, 4p.

Disclosed is a method of transporting liquid pitch containing lumpy coke wherein the lumpy coke contained in the liquid pitch is pulverized by a specific procedure, and the pitch containing the thus pulverized coke is then transported. Disclosure is also made for a specific apparatus used for the method.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 24638

23607 (PB—299861) **Outer continental shelf environmental monitoring concerns. Final report.** Slaughter, J. (Mitre Corp., McLean, VA (USA). METREK Div.). Jul 1979. Contract EQ8AC020. 78p. NTIS, PC A05/MF A01.

Information is presented on existing and proposed federal environmental monitoring programs applicable to oil and gas exploration, development, and production on the OCS. An analysis of the relevance of these programs to the needs of state and local governments affected by OCS activities is given. Discussion of significant unmet monitoring needs as perceived by participants in meetings held under the Outer Continental Shelf Oil and Gas Information Program of the Department of the Interior is included.

23608 Floating-type anti-oil anti-impact and anti-wave barrier. Toki, N. (to Mitsubishi Jukogyo Kabushiki Kaisha). US Patent 4,174,185. 13 Nov 1979. Filed date 14 Nov 1977. 6p.

A floating-type anti-oil, anti-impact and anti-wave barrier includes means for intercepting a flow of oil floating on the water and diverting the oil in directions at right angles to the original direction of flow, means for mitigating an impact force exerted by a ship or the like, and means for intercepting waves. The barrier comprises a first float formed by serially arranging at regular intervals a plurality of elongated floating boxes in their longitudinal direction, a second float formed exactly in the same manner as the first float and disposed parallel to the first float with opposed side surfaces of the floating boxes forming the first and second floats being located at staggered positions relative to each other. Floatable spacers having shock-absorbing and intercepting functions are interposed between such opposed side surfaces of the floating boxes in the first and second floats chains or ropes moor the respective floating boxes to each other.

23609 Floating-type anti-oil anti-impact anti-wave barrier. Kasai, H.; Fujii, H.; Toki, N. (to Mitsubishi Jukogyo Kabushiki Kaisha). US Patent 4,174,186. 13 Nov 1979. Priority date 27 May 1977, Japan, 10p.

A floating type anti-oil anti-impact anti-wave barrier includes structure for intercepting oil floating on the water, for mitigating an impact force exerted by a ship or the like, and for intercepting waves. The barrier can collect oil which has flowed out onto the sea to prevent the oil from dispersing, and the barrier can be protected from damage caused by a ship, by drift, by waves, etc.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 24638

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 24642

COMBUSTION

REFER ALSO TO CITATION(S) 24023

NATURAL GAS

RESERVES

REFER ALSO TO CITATION(S) 23572

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 23574

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 23580, 23586, 24791

23610 Process for alternately steam reforming sulfur containing hydrocarbons that vary in oxygen content. Lesieur, R.R.; Setzer, H.J.; Hawkins, J.R. (to United Technologies Corp.). US Patent 4,181,503. 1 Jan 1980. Filed date 30 Oct 1978. 6p.

In the hydrotreating and steam reforming of an oxygen and sulfur bearing hydrocarbon fuel, the oxygen is first removed in an oxidizer containing a bed of platinum catalyst, the inlet temperature being well below 1000°F and preferably on the order of 300°F. The sulfur in the fuel does not harm the oxidizer catalyst and may be removed downstream by known hydrodesulfurization techniques prior to reforming. A process is described for removing oxygen from an oxygen and sulfur bearing hydrocarbon fuel, such as peak shared natural gas, upstream in the process so that sulfur can be removed later. The fuel and some hydrogen are introduced into an oxidizer at a temperature of 350°F or less down to the minimum ignition temperature. The oxidizer consists of a platinum bed catalyst which catalyzes the oxidation of the oxygen to water with accompanying heat release to raise the exit gas temperature to less than 650°F. The temperature desorbs the sulfur from the catalyst, and the exit gases are passed downstream to nickel subsulfide or molybdenum desful-

fide catalysts where the hydrosulfurization process takes place. (BLM)

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 24209

HEALTH AND SAFETY

23611 (PB—300118) **Natural gas pipeline safety in residential areas served by master meters. a handbook.** Atallah, S.; Athens, P.; Jeffreys, D.; Lindstrom, R.; O'Brien, J. (Little (Arthur D.), Inc., Cambridge, MA (USA)). Apr 1975. Contract H-2178R. 112p. Paper copy available from the Sup. of Docs., Stock number 23-000-00315-5.

Prepared to make housing project managers, maintenance engineering staff, and designers and architects of HUD - assisted and HUD - insured housing projects and mobile home parks aware of their responsibilities under the Natural Gas Pipeline Safety Act, this handbook provides technical guidance for the reduction of gas leaks and the handling of gas leak incidents in residential areas. The hazards of natural gas, concern over gas safety in residential areas, applicable codes and standards, and sources of information and help are reviewed, along with maintenance and engineering considerations relating to gas pipe failures, the detection of gas leaks, appliance servicing, and pipe installation, repair, and replacement. Housing management considerations are also examined, with attention to recordkeeping and reporting, emergency contingency planning, tenant education, staff qualifications and training, and the development and use of a maintenance and operations manual. Master planning considerations are noted in terms of the location, layout, and construction of gas distribution systems and the selection, location, and installation of gas appliances. Guides to Federal pipeline safety regional offices, State agencies administering pipeline safety regulations, and selected publication by the American Gas Association are appended. Photographs, drawings, tables, and sample report forms are included.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 23601, 23604, 23605

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 23607

23612 (UCRL—15224) **Dynamics and modeling of heavier-than-air, cold gas releases.** Zeman, O. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Apr 1980. Contract W-7405-ENG-48. 55p. Dep. NTIS, PC A04/MF A01.

In this paper the phenomenon of gravity currents is examined with specific attention to heavier-than-air, cold gas releases such as during LNG spills. A one-layer model is developed which is capable of dealing with the inherently three-dimensional nature of such releases and which includes realistic initial conditions simulated by prescribing the gas boil-off velocity W/sub b/, within the spill area with scale L/sub o/. Dynamic similarity of the gravity currents is examined and similarity parameters (to interpret small experimental releases) are proposed. It is shown that a characteristic gravity spreading velocity varies as W/sub b//sup 1/3/L/sub o//sup 1/3/ with the depth scale of the layer proportional to (W/sub b/L/sub o/)/sup 2/3/. These scaling laws agree with the results from numerical experiments.

23613 **Gas industry and the environment.** Elmsford, NY; Pergamon Press, Inc. (1978). 277p. (CONF-7706195—).

From Symposium of the committee on gas of the Economic Commission for Europe; Minsk, Byelorussian, USSR (20 Jun 1977).

The use, exploration, preparation, transportation, storage, distribution, and environmental impacts of natural gas are discussed. Separate abstracts are prepared for individual items. (DC)

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 23611, 24642

STORAGE

23614 **Liquefied natural gas tank construction.** Baysinger, F.R. (to Kaiser Aluminum and Chemical Corp.). US Patent 4,181,235. 1 Jan 1980. Filed date 9 Jan 1978. 14p.

Improved method is claimed for manufacturing spherical cryogenic liquid holding tanks as well as the tanks produced thereby, where at least the major hemispherical portions of such tanks are formed from curvilinear elongated quadralateral plate members which in the case of a given tank each have substantially the same arcuate minor axis dimensional width when measured at the midpoint of the arcuate major axis but varying lengths. These plate members of varying lengths are initially selectively arranged and secured to each other to form a series of substantially symmetrical and uniformly dimensioned, individual, triangular spherical tank sectors or modules. These spherical sectors or modules are subsequently secured to each other such that the longest plate member of a given sector is located adjacent or in close proximity to the tank's equator while the midpoints of the major axes of the various plate members in such a spherical sector are located in substantially parallel relationship to each other and the tank's equator in the finished tank structure. 13 claims.

OIL SHALES AND TAR SANDS

23615 **Twelfth oil shale symposium proceedings.** Gary, J.H. (ed.). Contract EY-76-S-04-3780. Golden, CO; Colorado School of Mines (1979). 395p. (CONF-790440—).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

Thirty-nine papers are included. Separate abstracts were prepared for 34 of these papers; the remaining five papers have been previously abstracted. (DLC)

23616 **Eleventh oil shale symposium proceedings.** Gary, J.H. (ed.). EY-76-S-04-3780. Golden, CO; Colorado School of Mines (1978). 394p. (CONF-780460—). $12.00.

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

The oil shale topics covered in the 34 papers include health risks and environmental effects, reactions, various retorting projects, and shale properties. Separate abstracts were prepared for 30 of the papers; the remaining four have been previously abstracted. (DLC)

23617 **Bureau of Mines oil shale data bank.** Radcliffe, K.S.; Thill, R.E. (Bureau of Mines, Minneapolis, MN). pp 378-389 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

A computerized oil shale data bank has been created to collect and to evaluate literature and technical information pertinent to mining interests in oil shale, and to provide a means for efficient retrieval and dissemination of stored material. The data bank comprises five sections: (1) bibliographic references, (2) patents, (3) current research projects, (4) property data, and (5) data syntheses and analyses. Information contained in the oil shale data bank will be made publicly available by means of Bureau of Mines Information Circulars. Information retrieval services are also available. 14 figures.

SITE GEOLOGY AND HYDROLOGY

SITE GEOLOGY

23618 (METC/EGSP—108) **Isopach map of black shale in the Sonyea Group (from well sample studies).** Kamakaris, D.G.; Van Tyne, A.M. (New York State Museum and Science Service, Albany (USA); New York State Geological Survey, Alfred (USA)). 1980. Contract AS21-76MC05206. 40p. NTIS, PC A03/MF A01.

A map containing information on black shale deposits in the Sonyea Group in Western New York State was produced from well sample studies. (DC)

DRILLING, FRACTURING, AND MINING

REFER ALSO TO CITATION(S) 23634, 23652, 23653, 23662

23619 (LA—8104-PR) **Explosively produced fracture of oil shale. Annual report, April 1978-March 1979.** (Los Alamos Scientific

Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 87p. NTIS, PC A05/MF A01.

A generalized constitutive stress-strain relation, which includes the effects of both tensile and shear stresses on crack growth, is presented. A bedded-crack version of the fracture model was incorporated into the YAQUI hydrodynamics code. The average strain resulting from a random distribution of cracks in a stressed medium was used to determine the reduced modulus of the material. Tracer gas flow and pressure decay of a proposed oil shale retort were studied using a finite difference formulation of a Darcy fluid flow model. Preshot geologic characterization of the highly instrumented single-borehole explosive test shots in the Colony Mine is described. Crater blast data for both laboratory- and field-size experiments are given. Results were interpreted using empirical cratering and fragmentation techniques.

23620 (SAND—80-1134) **Directional drilling in tar sands.** McFall, A.L. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 13p. (CONF-800541—1). NTIS, PC A02/MF A01.

From Tar sands permeability enhancement workshop; Albuquerque, NM, USA (8 May 1980).

Special in-situ reservoir accessing schemes have recently been given increased consideration as a means of improving unconventional fossil fuel recovery. Specifically, the efficiency of thermal recovery methods for tar sands or very heavy oils may be significantly improved through the use of directional drilling techniques that allow additional reservoir intersection. This paper summarizes near-horizontal drilling experiences and discusses those special problems that can arise in drilling tar sands. Finally, the status of two current Sandia projects is presented. Water jet drilling of long horizontal holes from a vertical wellbore and the design of a high accuracy inertial survey system for deviated holes are each discussed.

23621 **Experiences in equipping a 96-inch-diameter shaft, and mining bulk samples of oil shale, dawsonite and nahcolite.** Cox, K.C. (Pittsburgh Mining and Safety Research Center, PA). pp 179-183 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

A 96-in. (2.4-m) diameter shaft was equipped to extract bulk samples of nahcolite, dawsonite, and oil shale. Quantities of water and methane gas were encountered in surprising volumes and pessures. This paper describes the physical facilties used in the encounter with high-pressured water and methane gas, and methods used in coping with the prblems. 10 figures.

23622 **Fracturing of the Antrim of Michigan.** Peil, C.A.; Humphrey, J.P. (Dow Chemical Co., Midland, MI). pp 227-241 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

Fracturing of oil shale is the key to extraction by in situ techniques; three different approaches are being tested in the field at a depth of 1300' (396.24 m). The first approach involves hydraulic fracturing, followed by sand propping and explosive rubblization. One method for hydraulically producing horizontal fractures has been tested, with vertical fractures resulting. The second approach is to create void space at the base of the Antrim by leaching away limestone layers and explosively fracturing shale into the void created. The third method is to explosively create void in the shale. Various methods for evaluating the results from fracturing have been or will be applied and are described in detail. 14 figures.

23623 **Drilling and casing a large-diameter shaft in he Piceance Creek Basin.** Utter, S.; Hawkins, J.E. (Bureau of Mines, Denver, CO). pp 292-310 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

The drilling and casing of an 8-ft (2.4 m) dia shaft to a depth of 2371 ft (723 m) in the Piceance Creek Basin of Colorado is described. This pioneer shaft allows access, for the first time, to the deep oil shales of the Saline Zone. The shaft was spudded in on March 25, 1977, and drilled to a total depth of 2371 ft 723 m) on October 2. Installation and cementing of the steel casing from surface to total depth were completed on December 27. Actual rig time was 237 days. Fishing operations took 59 days when the drill bit was lost in the shaft at a depth of 1245 ft (379 m). Results showed that a large-diameter shaft could be safely drilled through the Leached Zone in the Piceance Creek Basin. Problems encountered with the drilling assembly, drilling mud, and casing welding can be solved with improved designs. 26 figures.

OIL PRODUCTION, RECOVERY, AND REFINING

23624 **Product yields.** Heistand, R.N. (Development Engineering, Inc., Rifle, CO). pp 237-240 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

The product split between oil and gas in the Fischer Assay does not relate to any known oil shale retorting process. The Fischer Assay is a laboratory test; heat is transferred through the reactor wall; it is a batch process in which the energy products are separated by cooling to 0°C. Since both the crude shale oil and product gas are valuable energy products, a calculated Product Yield presents a truer picture of retort production. This Product Yield compares the retort products (oil and gas) with the Fischer Assay products (oil and gas). The Product Yield is based on the products produced from the retorting operations before any allowance for energy consumed. No credit is given for any process heat supplied from the raw shale feed. When this energy (expressed as MBtu/T) is included, Retort Yield can be calculated using products plus any heat supplied by the carbon residue on the shale. For the Paraho Direct Mode process, the Retort Yields are generally 100% of assay. Increases in this number are anticipated as more of the carbon residue is utilized.

IN SITU METHODS, TRUE AND MODIFIED

REFER ALSO TO CITATION(S) 23663, 23664, 23666

23625 (DOE/LETC/10787—44) **Investigation of the Geokinetics horizontal in situ oil shale retorting process. Quarterly report, January-March 1980.** Hutchinson, D.L. (Geokinetics, Inc., Concord, CA (USA)). May 1980. Contract FC20-78LC10787. 43p. NTIS, PC A03/MF A01.

Retort No. 18 produced 3479 barrels of oil during the quarter for a total of 4528 barrels to date. Chromatographic analyses of Retort No. 18 shale oil by the GKI analytical laboratory indicated variation in the oil from the wells near the air-in end and from the air-out end of the retort. Shale oil has been blended with Altamont crude (the Roosevelt refinery's normal feedstock); the distillation, API gravity, pour point, flash point, Naptha and Cat Gas were not affected by the shale oil. The diesel off the crude unit changed from water white to yellow, however, and a fine grayish-brown precipitate formed. Re-entry drilling was performed on Retorts No. 21, No. 22, and No. 23 during the quarter; tracer tests were run by Sandia Laboratories on Retorts No. 19, No. 21, No. 22, and No. 23. Blasthole drilling began on Retort No. 25.

23626 (FE—2346-48) **In situ combustion of Antrim oil shale: field test of Tejas petroleum engineers burner.** Cole, J.L.; Pihlaja, R.K. (Dow Chemical Co., Midland, MI (USA)). Jan 1980. Contract EX-76-C-01-2346. 15p. NTIS, PC A02/MF A01.

A major problem in having a successful in situ extraction experiment in Antrim oil shale has been the lack of a reliable ignition system. A reliable burner system has now been found. A methane burner was successfully tested for an intermittant 5-day period with a total of 82 hours of burner operation. The burner was ignited at 800 psig (well pressure) and reignited five times. The burner operated during the test at a theoretical gas temperature of 1200°F. Increased temperatures are possible with greater fuel to air ratios. The burner was monitored three different ways. Three thermocouples monitored exhaust gas temperature. A sample was taken of exhaust gas and analyzed for CO, CO_2, O_2 and unburned hydrocarbons. The burner pressure pulses were monitored by pressure gauges at the surface on the methane supply line. The three different systems gave an indication of whether the burner was operating. The only thing that the burner test idn't investigate was the upper safe operating temperature limit.

23627 (FE—2346-58) **Energy from in situ processing of antrim oil shale. Quarterly technical progress report, October-December 1979.** Washington, L.J. Jr. (Dow Chemical Co., Midland, MI (USA). Process Development Dept.). 21 Jan 1980. Contract EX-76-C-01-2346. 44p. NTIS, PC A03/MF A01.

Extraction trials on the new site were begun. The first trial, F80-1, was completed in Well No. 301 in October, 1979. Using a methane burner and an ignition service from TOR Developments, Inc., downhole burner ignition was readily achieved. Shale ignition occurred within two days. Combustion in the wellbore was so intense that the burner was lost, and subsequently shale combustion decreased and the trial was terminated. After some modification of equipment and procedures, the second trial, F80-2, was begun in late November, 1979. Combustion was achieved and the trial was still in progress at the end of the quarter.

23628 (FE—2346-64) **Energy from in situ processing of antrim oil shale. Quarterly technical progress report, January-March 1980.** Washington, L.J. Jr. (Dow Chemical Co., Midland, MI (USA).

Process Development Dept.). 18 Apr 1980. Contract EX-76-C-01-2346. 35p. NTIS, PC A03/MF A01.

Extraction trials on the new site were continued until the end of the quarter, the maximum length of time provided for in the contract. Trial F80-2, which began November 20, 1979, was terminated in February, 1980. Shale combustion was achieved during this trial and low Btu gas was recovered from production wells and from the injection well during depressurization of the formation after air injection was terminated. However, the proportion of gas recovered was low; possibly due to loss of injection gases through a break in the well casing. Trial F80-3 was carried out in March, 1980, with the burner in Well No. 305 which had not been previously used as an injection well. Good communication existed between Well No. 305 and 306 and initial recovery rates were 85 to 90%. Shale ignition was achieved without difficulty. Analysis of input and output gases gave a good accounting of oxygen and showed that significant quantities of shale were burning. Pressure drop between the input and output wells increased significantly during the period when there was evidence of in situ combustion. Further evaluation of this trial will be completed in the next quarter and will be included in a topical report.

23629 (LETC/RI—79/11) **Production of SNG from shale oil by catalytic gasification in a steam-hydrogen atmosphere.** Stagner, M.J.; Barker, L.K. (Department of Energy, Laramie, WY (USA). Laramie Energy Technology Center; Geological Survey, Grand Junction, CO (USA)). Dec 1979. 26p. NTIS, PC A03/MF A01.

This report presents the results from experiments performed at the Laramie Energy Technology Center (LETC) of the Department of Energy (DOE) to produce a substitute natural gas (SNG) from shale oil via catalytic gasification in a steam-hydrogen atmosphere. Also contained is a comparison of the yields of SNG obtained with those from previous experiments performed at LETC in which shale oil was catalytically gasified in a pure hydrogen atmosphere. The maximum yield of gas obtained in the Stream-hydrogen experiments corresponded to 75 wt % of the feed carbon being recovered as gas. This maximum yield was obtained at the highest temperature (1300°F (978°K)) and hydrogen partial pressure (900 psig (6205 kPa)) tested, while the gas yield for gasification in a pure hydrogen atmosphere was 86 wt % of feed carbon at similar operating conditions. The reduced yield was attributed to poisoning of the cobalt-molybdate catalyst employed by carbon monoxide generated in small amounts from the reaction of steam with carbon and/or hydrocarons in the gasification reactor.

23630 Post-burn study of the Rock Springs, Site 9 in situ retorting experiment. Lawlor, D.L. (Laramie Energy Technology Center, WY); Latham, D.R.; Fausett, D.W.; Asplund, R.O. pp 221-227 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

The use of cluster analysis techniques to analyze chemical and physical property data from bitumens and oils has produced information on the extent of the vertical and horizontal progression of the thermal zones from the Rock Springs Site 9 pure in situ retorting experiment. The upper fracture system displays the most extensive amounts of thermal evidence. The lower fracture system has the next most extensive thermal evidence, followed by the middle fracture system. Data on the thermal halo or induction zone that brackets the retort zone, shows the shale to be affected vertically as much as 4.5 m (15 feet) and horizontally as much as 39 m (130 feet). Numerous examples of isolated thin thermal zones are evident; some are 1 foot (0.3 m) thick, not apparently associated with fractures. Retorting directions were determined to be northwest and southeast in the upper fractures and easterly in the lower fracture.

23631 Progress report on the geokinetics horizontal in situ retorting process. Lekas, M.A. (Geokinetics, Inc., Concord, CA). pp 228-236 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

A process with low front end costs was developed for shallow oil shale deposits; its name is LOFRECO. A pattern of blastholes is drilled into the oil shale bed. The blast results in a well-fragmented mass of oil shale which is used as an in-situ retort. After four years of field work since 1975, 18 retorts have been blasted and 11 retorts burned, producing over 5000 bbl, shale oil. 15 figures. (DLC)

23632 Comparison of dielectric heating and pyrolysis of eastern and western oil shales. Snow, R.H.; Bridges, J.E.; Goyal, S.K.; Taflove, A. (IIT Research Inst., Chicago, IL). pp 283-298 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

Performance of the IITRI RF process was tested by dielectrically heating both 86 to 172 l/tonne (25 to 50 gal/ton) Colorado and 14 to 18% carbon Eastern oil shale under simulated overburden pressure. The rate of pyrolysis is much faster for Eastern than for Western shale above 350°C. Recovered oil yield from Colorado shale was 90% of Fisher assay. The oil was much lighter than that from other processes, 44% boiling in the naptha and kerosene range. Nitrogen content was less than 1%. High autogenous gas pressures are developed to drive out products, and experiments were done with up to 20 atm for Eastern shales. This affected the yield only slightly, increased the reaction temperature, and resulted in more valuable hydrocarbons. Permeability measurements of Western shale during and after pyrolysis were 200 millidarcies at an overburden pressure of 20 atm. With Eastern shales, permeabilities ranged from 4 to 150 millidarcies perpendicular to the bedding plane and much higher values parallel to the bedding planes. Eastern shale does not swell as Western shale does. Net energy ratios (NER) to recover oil and gas from the Eastern shales were found to be in the order of 3 based on products only from the RF pyrolysis step. This NER can be significantly improved by gasification of the pyrolytic carbon. Sufficient permeability exists for gasification, and a post-gasification leaching process to recover co-products, such as uranium. 8 figures, 9 tables.

23633 Evaluation of retort performance from gas data. Raley, J.H. (Univ. of California, Livermore). pp 342-351 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

Improved methods for diagnosis and control are especially valuable for in situ retorts because of limited emplaced instrumentation. The possibilities for using off-gas data to monitor performance will be illustrated by results from combustion retorting in pilot, simulated in situ retorts. The size and variation of the ethene/ethane, or propene/propane, ratio in the off-gas during retorting give a measure of the smoothness of the operation. These ratios also indicate the loss in oil yield resulting from cracking and oxidation. Off-gas hydrogen content measures the extent of steam reactions with char and carbon monoxide. Intra-retort gas data are useful also for detecting conditions conducive to oil loss and for portraying the progress of the retorting operation. 14 figures, 3 tables.

23634 Characterization, fracturing, and true in situ retorting in the Antrim shale of Michigan. McNamara, P.H.; Peil, C.A.; Washington, L.J. (Dow Chemical Co., Midland, MI). pp 353-365 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

A multi-faceted program is being conducted to test the feasibility of extracting energy from the Antrim shale of Michigan. This paper provides a progress report on three phases of that work. With the help of scientists and engineers at five Michigan universities, a data base is being compiled which will allow assessment of the Antrim resource. Results of these geochemical, geophysical, lithological and mineralogical studies are presented and discussed. At Dow's field site, the three in-situ fracturing experiments are nearing completion. A brief review of these experiments along with a preliminary assessment of the results is given. Strategies for the true in-situ retorting trial scheduled for August, 1979, are being formulated. The experience gained in previous trials coupled with the predictions of several mathematical models will be used to guide the effort. These experiences and predictions are described. 17 figures.

23635 High temperature reactions of oil shale minerals and their benefit to oil shale processing in place. Smith, J.W.; Robb, W.A.; Young, N.B. (Dept. of Energy, Laramie, WY). pp 100-112 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

Limited temperatures reached by Green River Formation oil shale during surface retorting restrict accompanying mineral reactions to decompositions whose products may have aqueous and gaseous mobility. The substantially higher temperatures reached during combustion processes in place initiate solid-state mineral reactions. Three solid-state reactions are examined: (1) gas-solid combination retaining sulfur in the shale; (2) solid-solid formation of new minerals; and (3) gas-solid recarbonation. To evaluate the unknown solid-solid reactions, tests were conducted on two samples representing possible resources for in situ combustion, heating them to temperatures up to 1200°C. New minerals appearing in samples during these experiments were identified by x-ray diffraction. Evaluation of all these solid state reactions indicate that they work to minimize possible environmental consequences of in situ oil-shale development. 6 figures, 3 tables.

23636 Extraction of hydrocarbons from Antrim oil shale. Humphrey, J.P. (Dow Chemical Co., Midland, MI). pp 147-157 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

A variety of in-situ experiments were performed on the Antrim oil shale which underlies Michigan. These experiments have ranged from in-situ combustion in a quarry to attempted extraction at a depth of 2600 feet (780 m). Currently, Dow is continuing its efforts to obtain hydrocarbons from this resource on a four-year contract (Contract No. EX-76-C-01-2346) in cooperation with the Department of Energy. A site, prepared through explosive fracturing, is being tested. Extensive permeability tests have been performed and attempts have been made at initiating partial combustion within the formation. Extensive laboratory experiments have been coupled with Dow's efforts to recover hydrocarbons in situ. These tests have been carried out under a variety of different atmospheres, pressures, and temperatures and in various types of apparatus. In general, results show that hydrocarbons can be extracted in many ways and the products produced and yields obtained will vary accordingly.

23637 Progress in Occidental's shale oil activities. Ridley, R.D. (Occidental Oil Shale, Inc., Bakersfield, CA). pp 169-175 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

This paper traces the development of modified in-situ processing and describes Occidental's plans for commercial operations on Tract C-b. (DLC)

23638 Spent shale compaction for void volume generation in in situ oil shale processing. Young, C. (Science Applications, Inc., Fort Collins, CO); Trent, B.C.; Harak, A.E.; Maxwell, D.E.; Watson, J.D. pp 282-291 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

Explosive compaction of spent shale in an in situ retort has been suggested as a means of obtaining the void volume required for the successful generation of subsequent retorts. Static compaction experiments and explicit finite-difference calculations were used to provide a preliminary evaluation of the spent shale compaction concept. These experiments have provided basic compaction data on fragmented and reconstituted samples of oil shale from the Tipton Member of the Green River Formation in Wyoming. The data demonstrate that the energy required for compaction decreases with retorting temperature. Richer shales appear to offer less resistance to compaction for the same retorting history. One-dimensional finite-difference calculations, representative of simplified field geometries, were used to evaluate the sensitivity of compaction behavior to explosive characteristics, seismic coupling and compaction properties. These calculations indicate that for compaction at elevated temperatures, no more than a few pounds of explosive per ton should be sufficient to provide adequate compaction for a continuous in situ process. 8 figures.

SURFACE METHODS

23639 (UCID—18618) Oil Shale Project Run summary. Small Retort Run S-16. Ackerman, F.J.; Sandholtz, W.A.; Carley, J.F.; Raley, J.H.; Tripp, L.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1980. Contract W-7405-ENG-48. 71p. Dep. NTIS, PC A04/MF A01.

Purpose of S-16 was to determine whether fine material with a narrow size distribution would give yields equivalent to runs having fines with a much broader size distribution. The run gave very high oil yield, 99% of Fischer assay. High temperatures seem to be associated with small particles. Wide particle size distributions induce flow complexities resulting in oil burning and degradation. 27 figures, 16 tables. (DLC)

23640 Recovery of bitumen from tar sands. Veatch, F.; Alford, H.E. (to Standard Oil Co.). US Patent 4,174,263. 13 Nov 1979. Filed date 28 Jun 1978. 6p.

Bitumen is separated from tar sands by contacting the tar sands with a small amount of liquid, heating the liquid treated tar sands to expand the liquid as a vapor thereby reducing the density of the bitumen and separating the bitumen from the remainder of the tar sands on the basis of density.

23641 Process of treating bituminous sands conveyor belt with release agent. Sanford, E.; Shaw, R. (to Petro-Canada Exploration Inc.). US Patent Patent 4,172,811. 30 Oct 1979. Filed date 1 Nov 1977. 4p.

A process for treating a conveyor belt carrying bituminous sands with a release agent comprises applying to the sands-bearing surface of the belt, piror to deposition of the bituminous sands, a water-based emulsion having as the disperse phase a silicone fluid having short hydroxyl-terminated polymer chains and a viscosity on the order of 100 centistokes; unloading the sands from the belt; and recovering the bitumen from the sands using a hot water extraction step. The emulsion acts as a release agent which effects clean separation of the sands from the belt surface during unloading and does not deleteriously affect the primary bitumen recovery in the extraction step.

23642 Recent Paraho operations. Jones, J.B. Jr. (Paraho Development Corp., Grand Junction, CO); Heistand, R.N. pp 184-194 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

Under contract with the Office of Naval Research and Department of Energy, Paraho performed retorting research directed towards supplying, transporting, and refining of up to 14,400 tons (100,000 barrels) of crude shale oil. During the 1977-78 research-production project, several milestones were achieved: Long continuous operations, high onstream factors, good material balance closures, good yields, and significant research results. This paper discusses the milestones and presents data on the Paraho operations.

REFINING

REFER ALSO TO CITATION(S) 23590, 23594

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 23634

23643 (FE—2346-37) Ultrasonic velocity and elastic constants of Antrim oil shale. Wallace, W.D.; Tepley, N.; Thomas, R.L. (Dow Chemical Co., Midland, MI (USA)). Jan 1980. Contract EX-76-C-01-2346. 16p. NTIS, PC A02/MF A01.

Ultrasonic velocities have been measured in 30 core samples from well 201. Both longitudinal and shear wave velocities were measured across core diameters at thirty degree intervals around the circumference in 22 of the samples. No significant angular variation of ultrasonic velocity was found in any of these. Plots of the average velocities between 1166 feet and 1486 feet are presented. In the Antrim, which lies between 1179 feet and 1422 km/s and the average shear wave velocity is 2.60 km/s. Actual velocities in the Antrim vary by + - 6% from these averages. Just above and below the Antrim the measured velocities are somewhat greater than the average Antrim values. Mass densities have also been determined for these samples and combined with the velocity data to obtain elastic constants.

23644 Pipeline transportation of oil shale. Link, J.M.; Pouska, G.A.; Faddick, R.R. (Colorado School Mines, Golden). pp 260-272 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

A test program was initiated to conduct pipeline studies of raw and spent oil shale slurries. Shale slurries were recirculated in horizontal test section pipeline loops, having diameters of 150 and 220 mm, and in a 150-mm diameter vertical test section. Slurry concentrations, from 10 to 60 wt %, were investigated. Critical and deposition velocities were observed. Head losses were measured at various velocities. Rheology measurements were made on homogeneous subsamples from the pipeline. From these data, pipeline energy requirements were predicted by computer and compared to pipeline data. Computer programs were also used to analyze pipeline data for two flow models: heterogeneous flow regime for coarse, settling slurries, and homogeneous flow regime for nonsettling suspensions. The economics of slurry transport of oil shale were compared to alternative transportation means. Best cost studies were made, covering the wide range of pipeline diameters required to transport both raw and spent shale in varying concentrations. 15 tables.

23645 Geotechnical properties of a fine-grained spent shale waste. Peterson, R.W. (Army Corps of Engineers, Vicksburg, MS); Townsend, F.C.; Bloomfield, R.A. pp 273-281 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

Objective of this laboratory investigation was to determine the physical properties, compaction, consolidation, shear strength, and permeability parameters of a spent shale. Physical properties consisted of grain size distribution, Atterberg limits after nine months of soaking in water, and specific gravity determinations. Six-

in.-dia compaction tests and 12 in.-dia consolidation tests were used to determine compaction and consolidation characteristics and particle break down for three compactive efforts. Unconfined compression and consolidated-undrained triaxial compression tests on 6-in.-dia specimens, compacted to three densities, were performed to evaluate compressive strength gains over 28 days, and total and effective strength parameters for undrained conditions. Companion 3- by 3-in. consolidated-drained direct shear tests on specimens compacted to one density were used to obtain strength parameters for drained conditions. Permeability values for the spent shale were also determined on the consolidated-undrained triaxial test specimens. Results showed that the spent shale is a silty sand and that, with proper compaction, it possesses a good shear strength, has a low permeability with minimal compaction, and exhibits some self-cementing tendencies. 10 figures.

23646 Effects of mositure and organic content on the thermophysical properties of Green River oil shale. DuBow, J.; Nottenburg, R.; Rajeshwar, K.; Wang, Y. (Colorado State Univ., Fort Collins). pp 350-363 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

Certain trends are apparent in the behavior of the thermophysical properties of oil shale as a function of temperature and grade and moisture content: (1) thermal conductivity decreases with increasing grade and increasing temperature; (2) thermal diffusivity decreases with increasing grade and increasing temperature; (3) extent of mechanical yield increases with increasing grade; (4) dielectric constant, dielectric loss and loss tangent show a weak grade-to-grade dependence; (5) the presence of moisture gives rise to interfacial polarization which can be eliminated by drying. However, grade dependence at lower frequencies still remains weak; (6) thermal conductivity and thermal diffusivity are greater parallel to the varves than perpendicular to the varves; (7) electrical resistivity is also greater parallel to the varves than perpendicular to the varves; (8) dielectric constant, dielectric loss and loss tangent are not seen to be dependent on orientation, at least in initial data; (9) the yield point is absent parallel to the varves. These conclusions indicate that heat flow is faster parallel to the varves. Retort columns will be stronger parallel to the varves than perpendicular to them. Electrical assay techniques are probably not applicable, except at frequencies in excess of 1 MHz. 16 figures.

DIRECT USES AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 23606

23647 (PB—299940) **The use of waste and low-grade materials in road construction. 6. Spent oil shale.** Burns, J. (Transport and Road Research Lab., Crowthorne (UK)). [nd]. 22p. NTIS, PC A02/MF A01.

The use of low-grade and waste materials as alternatives to naturally occurring aggregates in the construction of roads helps to conserve the supplies of good quality aggregates and assists in problems arising from the disposal of unwanted materials. This report is one of a series on individual materials which is aimed at bringing together the information that is available on each of the major waste products that have roadmaking potential. It deals with spent oil shale and it considers the extent to which this type of shale can be used in road construction. The report discusses the types and quantity of shale that are available, the purposes to which it can be put in road construction and the tests needed to ensure that shales meet the required specifications. (Copyright (c) Crown Copyright 1978.)

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 23660, 24765

23648 Toxicological evaluation of an in situ oil shale process water. Hepler, D.I. (Elars Bioresearch Labs., Inc., Fort Collins, CO); Schafer, A.S.; Larson, K.A.; Farrier, D.S. pp 139-148 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

This paper describes the results of exposure studies, acute toxicity studies, and reproduction-developmental studies undertaken to define health risks associated with occupational exposure to a retort water sample produced during the Laramie Energy Technology Center's 1976 Rock Springs Site 9 true in situ oil shale combustion experiment. This sample was designated Omega-9 retort water. This investigation represents the first animal toxicity evaluation of a retort water and therefore incorporated a broad base of various tests selected to determine toxicity as a function of exposure route and species exposed. Results are interpreted as to their occupational health significance. On the basis of this study a limited number of specific tests have been selected for use in cost-effective, comparative screening of additional retort waters, and waters significant to oil shale processing, in general.

23649 DOE/EV Task Force on the environmental and health effects of modified in situ oil shale processes. Chappell, W.R. (Univ. of Colorado, Boulder). pp 149-155 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

In May of 1978 Governor Lamm of Colorado wrote to Secretary Schlesinger requesting DOE assistance in the analysis of oil shale impacts, particularly those relating to modified in situ (MIS) processes. In response, the Office of the Environment (EV) of DOE created a Task Force to plan, implement, and coordinate a comprehensive, integrated research program. This program involves five major areas of activity: (1) source characterization, (2) health effects, (3) environmental fate and effects, (4) environmental control technology, (5) integrated assessment. The research is being conducted at several national laboratories and universities. The MIS Task Force activities are reviewed.

23650 Chemical and physical properties of oil shale dust and correlations with laboratory fire and explosivity test results. Atwood, M.T.; Goodfellow, L.; Kauffman, R.K. (Tosco Corp., Denver, CO). pp 299-315 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

Test materials included oil shale dusts varying in richness (Fischer assay oil yields) and particle size. These samples were either freshly prepared or obtained from dust deposits in the Colony oil shale mine. Analyses carried out included Fischer assay and determination of total volatile hydrocarbons, organic carbon and pyritic sulfur. Data were obtained at the Denver Research Institute on laboratory dust ignition and explosivity properties and on the tendency for spontaneous ignition, and the values were correlated with the chemical properties. Ignition and explosivity properties increase as the organic content of the oil shale dust increases and as the particle size decreases. However, oil shale dusts were shown to be much less explosive than coal dusts. 14 figures, 18 tables.

23651 Laboratory and fire explosivity testing of oil shale dust. Williams, R.E.; Zborovsky, Z.; Blunt, R.M.; West, D. pp 316-325 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

Explosivity tests, as described in the US Bureau of Mines RI 5624, were conducted on prepared new and aged oil shale dusts. Tests included minimum ignition concentration, temperature, energy, maximum pressure, and rate of pressure rise. In addition, dust layer ignition data were obtained as well as the potential for oil shale to spontaneously combust. A high Btu retort gas was tested for minimum ignition energy and limits of flammability. A preliminary evaluation was made on rubble fires. Oil shale dust layers can ignite at temperatures found in mining, handling and processing operations. Oil shale is less liable to spontaneous combustion than typical western coals. Oil shale rubble burns with difficulty and does not propagate under the conditions of the test procedure. A nonexplosive methane/air mixture and a nonexplosive oil shale dust when combined did ignite and explode. High Btu retort gas is more dangersous than methane in terms of minimum ignition energy.

23652 Potential for fires and explosions in oil shale mining and processing. Crookston, R.B.; Hoskins, W.N. (Tosco Corp., Denver, CO). pp 326-338 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

Studies of the concentration and character of dust on surfaces in an oil shale mine suggest that the potential hazard of mine dust explosions may be less than that of fires in oil shale rubble and of the mine itself. Although the potential hazard and consequences from mine fires have not yet been measured, two very recent unplanned fires in oil shale mines suggest caution. Methane in small concentrations has been encountered in oil shale exploration and mining. Scenarios of possible fire and explosion events highlight these potential hazards, and suggest the need for thoughtful research, and a deliberate, but carefully studied approach to promulgating specific regulations, if any are proven necessary. The studies that have been sponsored by/or conducted for the Bureau of Mines, have so far served to establish the existence, if not the measure, of the potential hazards. 13 figures, 3 tables.

23653 Methane encountered at the Bureau of Mines oil shale shaft. Vinson, R.P.; Cox, K.C.; Kissell, F.N. (Bureau of Mines, Pittsburgh, PA). pp 339-341 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

In studies published in 1975, the Bureau of Mines called attention to the possibility that deep oil shale mines would be gassy. The presence of methane gas in mines creates an additional hazard as well as impacting the economics of mining. In November 1978, a methane ignition occurred in the Bureau of Mines oil shale research shaft in Colorado, which was subsequently classified as gassy by the Mine Safety and Health Administration. In December 1978, a second ignition was followed by a fire that necessitated flooding of the shaft. The paper briefly reviews the circumstances surrounding these incidents and their implication for methane gas hazards in other oil shale deposits.

23654 Health studies of oil shale workers. Costello, J. (NIOSH, Morgantown, WV). pp 10-14 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

Review of the literature indicates potential health problems for shale oil workers in the form of respiratory and skin diseases. The first USPHS morbidity study concluded that contact with shale oil did not produce skin lesions. A NIOSH mortality and morbidity study is now underway on people who worked at the Anvil Points and Union Oil retorts. (DLC)

23655 Evaluation of comparative toxicity and shipboard hazards of selected petroleum and oil shale-derived fuels. Cowan, M.J. (Wright-Patterson Air Force Base, OH); Jenkins, L.J.; Doptis, L.E.; Young, R.W. pp 21-31 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

Since the initiation of Project INDEPENDENCE, the Navy has been active in the production of shale oil crude by surface retorting, as well as the refining of crude shale oil into product fuels for military use. Information on the health effects of these product fuels is needed in order to determine the adequacy of engineering controls limiting exposures of personnel using fuels, and for the formulation of safe work procedures in naval shipboard and shore facilities. Naval activities to identify health effects associated with selected shale oil fuels, in comparison with their petroleum-derived analogs, and to characterize fuel exposures of personnel, are described. 15 tables.

23656 Toxic trace elements and oil shale production. Chappell, W.R. (Univ. of Colorado, Boulder). pp 32-42 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

An interdisciplinary, tri-university research program on the potential release of toxic trace elements by shale oil production has the objective of determining if shale oil production will lead to the emission of significant amounts of toxic trace elements such as As, B, F, Mo, and Se into the environment. An intensive field sampling of surficial material, leachates, revegetation plots, and retort material, as well as laboratory studies, is being performed in order to determine the leachability of raw and processed shales and the ultimate fate of trace elements that were mobilized by retorting oil shale. Results of the first two years of study are presented. Results to date indicate that As and Se are not of great concern in aqueous effluents and plants, while, on the other hand, F, B, and Mo are of concern and require further study. 4 figures, 5 tables.

MARKETING AND ECONOMICS

23657 Economic issues in oil shale leasing policy. Jones, R.O. (Univ. of California, Santa Barbara); Mead, W.J.; Sorensen, P.E. pp 203-213 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

The pure bonus bidding system without royalty or other payments will maximize economic rents available to the government from oil shale resources. All other systems are less efficient and will reduce the net gains available to society. Under reduced economic rents, the standard of living of society is lower than would be the case under an efficient system. If, for political reasons, a fixed royalty payment must accompany a bonus bidding system, then the sacrifice in economic rent can be lowered by allowing such royalty requirements to be reduced toward zero as leases approach exhaustion. Environmental and other regulations having social costs in excess of their social benefits should be avoided.

WASTE RESEARCH AND MANAGEMENT

REFER ALSO TO CITATION(S) 24645

23658 Water management for oil shale mining and retorting in the Piceance Creek Basin, Colorado. Brown, A. (Golder Associates, Inc., Vancouver, British Columbia); Stewart, B.M. pp 214-226 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

This paper describes the results of part of a project which addresses the water management aspects of the Colorado oil shale industry, looking in detail at three sites in the Piceance Basin, and a number of commercial-sized mines/retort complexes at each site. Mine water inflow has been estimated from detailed studies of geology and available hydrology data. Net water requirements of processing and disposal have been determined for several process and disposal scenarios at each site. From these two results, the likely water surplus or deficit is found. Within the framework of legal and regulatory agency constraints, optimal ways of obtaining make-up water, and/or disposing of any water surplus have been determined. 7 figures, 5 tables.

ENVIROMENTAL ASPECTS

REFER ALSO TO CITATION(S) 23668

23659 (DOE/EA—0095) **Environmental assessment: DOE/Occidental Oil Shale, Inc. cooperative agreement, Phase II, oil shale retorting, Logan Wash Site, Garfield County, Colorado.** (Occidental Oil Shale, Inc., Grand Junction, CO (USA)). Nov 1979. 88p. NTIS, PC A05/MF A01.

The Occidental modified in situ process for producing shale oil is discussed. The environmental impacts of Phase II oil shale retorting are reported. A description of existing conditions of air quality, water quality, and ecology of the Logan Wash Site in Garfield County, Colorado is presented. The potential environmental impacts of the construction phase, operation phase, and post-operation phase are discussed. The aesthetic, recreational, cultural, socio-economic, health, and safety aspects of this project are also covered. (DC)

23660 (DOE/EV—0078) **Environmental research on a modified in situ oil shale task process. Progress report.** (Department of Energy, Washington, DC (USA). Div. of Ecological Research). May 1980. 108p. NTIS, PC A06/MF A01.

This report summarizes the progress of the US Department of Energy's Oil Shale Task Force in its research program at the Occidental Oil Shale, Inc. facility at Logan Wash, Colorado. More specifically, the Task Force obtained samples from Retort 3E and Retort 6 and submitted these samples to a variety of analyses. The samples collected included: crude oil (Retort 6); light oil (Retort 6); product water (Retort 6); boiler blowdown (Retort 6); makeup water (Retort 6); mine sump water; groundwater; water from Retorts 1 through 5; retort gas (Retort 6); mine air; mine dust; and spent shale core (Retort 3E). The locations of the sampling points and methods used for collection and storage are discussed in Chapter 2 (Characterization). These samples were then distributed to the various laboratories and universities participating in the Task Force. For convenience in organizing the data, it is useful to group the work into three categories: Characterization, Leaching, and Health Effects. While many samples still have not been analyzed and much of the data remains to be interpreted, there are some preliminary conclusions the Task Force feels will be helpful in defining future needs and establishing priorities. It is important to note that drilling agents other than water were used in the recovery of the core from Retort 3E. These agents have been analyzed (see Table 12 in Chapter 2) for several constituents of interest. As a result some of the analyses of this core sample and leachates must be considered tentative.

23661 (PB—300536) **Groundwater quality monitoring of western oil shale development: identification and priority ranking of potential pollution sources.** Slawson, G.C. Jr. (General Electric Co., Santa Barbara, CA (USA). Center for Advanced Studies). Jan 1979. Contract EPA-68-03-2449. 241p. NTIS, PC A11/MF A01.

This report presents the development of a preliminary priority ranking of potential pollution sources with respect to groundwater quality and the associated pollutants for oil shale operations

such as proposed for Federal Prototype Leases U-a and U-b in Eastern Utah. The methodology used includes description of background information and the proposed oil shale operations as potential pollution sources, characteristics of potential pollutants, area water use, the hydrogeologic framework of the project area, and existing water quality. This information base is then used to evaluate the potential mobility of pollutants in the subsurface through consideration of infiltration, and mobility and attenuation processes in unsaturated and saturated zones. These facts lead to the preliminary priority ranking based on the magnitude of the sources; the toxicity, persistence, etc., of the potential pollutants; the mobility of pollutants in the subsurface; and the potential for harm to water users.

23662 Environmental analysis for the Bureau of Mines oil shale research facility. Schottler, G.R. (Bureau of Mines, Denver, CO); Leonard, G.J. pp 94-99 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

The Federal Bureau of Mines has conducted a continuing program of environmental analaysis for its oil shale Mining Environmental Research program centered around the 8-foot-diameter bored shaft in Horse Draw in the central part of the Piceance Creek Basin. The purpose of this analysis program is to determine potential adverse effects of the research program on the environment before they become reality so that any necessary monitoring can be started and mitigating measures developed. This paper describes the existing environment of the Bureau's oil shale research tract and summarizes the development of the facility up to the present with emphasis on the environmental analysis that has been conducted coincident with development. Significant findings of the environmental analysis program are presented. It was concluded from its environmental assessment that the potential benefits resulting from a proposed program of mining environmental research conducted at the facility more than offset the relatively minor negative environmental impacts that would result from the program.

23663 Microbial interactions with aqueous effluents derived from in situ fossil fuel processing. Williams, S.E. (Univ. of Wyoming, Laramie); Gauger, W.K.; Farrier, D.S. pp 115-121 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

An aqueous effluent obtained from the Laramie site 9 in situ oil shale processing experiment located near Rock Springs, Wyoming was studied. Microorganisms were shown to survive and grow in this process water (Omega-9 water). Populations of microorganisms present in the Omega-9 water exhibit growth kinetics typical of single-celled organisms. Bacteria and actinomycetes have been isolated from the water on standard quantification and isolation media and on a medium in which the organics of the retort water are the only carbon sources available for microbial growth. Pseudomonas aeruginosa and Pseudomonas putida, genetically modified to metabolize complex or recalcitrant organic compounds were inoculated into filter sterilized Omega-9 water and did not grow in it. Mixed culture growth of microorganisms in Omega-9 water was recorded spectrophotometrically. Samples taken during growth were subjected to DOC fractionation and analysis. Changes in total dissolved organic carbon, total hydrophobics, hydrophobic neutrals and pH were correlated significantly with time, possibly as the consequence of microbial growth.

23664 Phytotoxicity and plant response to aqueous effluents derived from an in situ oil shale process water. Skinner, Q.D. (Univ. of Wyoming, Laramie); Moore, T.S.; Asplund, R.O.; Sexton, J.C.; Farrier, D.S. pp 122-138 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

Two screening procedures have been developed (seed germination assay and growth response assay) for testing the effect of aqueous effluents on plant life. Omega-9 water was utilized as the test water. Results show that methods used will distinguish different seed and plant responses in respect to different dilutions of Omega-9. These diagnostic screening procedures are versatile, quantitative, reproducible, and can be carried out in a short time frame. Experimental methods are conducted within laboratory and greenhouse facilities utilizing hydroponic culture systems. This approach allows control over environmental parameters. The developed screening methods may now be used to assess the response of a variety of plants to different waters. Such data will be of significant use in determining potential risks associated with untreated waters and determining the acceptibility for surface disposal of treated waters. 8 figures, 7 tables.

23665 Trace element release and transport associated with shale oil production. Chappell, W.R. (Univ. of Colorado, Boulder). pp 156-165 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

A review of recent progress of an interdisciplinary, tri-university research program is given. This program involves faculty from the University o Colorado, the Colorado School of Mines, and Colorado State University. Objectives of the program is to determine if shale oil production will lead to the emission of significant amounts of toxic trace elements such as B, F, Mo, As, and Se into the environment. Results of the third year of the study are presented.

23666 Potential toxic effects on aquatic biota from oil shale development. Skogerboe, R.K.; Natusch, D.F.S.; Taylor, D.R.; Dick, D.L. (Colorado State Univ., Fort Collins). pp 43-46 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

Research designed to assess potential impacts of effluents resulting from oil shale development on the aquatic biota has been in progress for two years. Primary objectives are: (1) to establish the extent to which these effluents can contaminate the aquatic system; (2) to characterize the chemical constituents entering the aquatic system; (3) to identify the principal toxicants present in the effluents with emphasis on the aquatic biota; and (4) to determine the transformation and transport behaviors of the toxic entities. Results of studies carried out on retorted oil shale leachates are discussed.

23667 Environmental research for in situ oil shale processing. Farrier, D.S.; Virgona, J.E.; Phillips, T.E.; Poulson, R.E. (Dept. of Energy, Laramie, WY). pp 81-99 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

The US Department of Energy is engaged in broad, multidisciplinary research to address the environmental concerns associated with in situ oil shale processing. A significant portion of this research effort has been directed at the characterization, transport, geohydrological interactions, biological effects, containment, treatment, and utilization of waters, heavily laden with organic and inorganic solutes, which are produced during the in situ process. This paper discusses the sources and quantities of produced retort waters and provides a summary overview of water-related environmental research, conducted principally through the Laramie Energy Research Center (LERC) since 1974, in conjunction with simulated and field in situ processing experiments.

REGULATIONS

23668 (PB—299179) Energy from the west: energy resource development systems report. Volume III: oil shale. Final report, 1975-1978. White, I.L.; Chartock, M.A.; Leonard, R.L.; Ballard, S.C.; Gilliland, M. (Oklahoma Univ., Norman (USA). Science and Public Policy Program; Radian Corp., Austin, TX (USA)). Mar 1979. Contract EPA-68-01-1916. 328p. NTIS, PC A15/MF A01.

This report describes the technologies likely to be used for development of oil shale resources in eight western states (Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, and yoming). It provides information on input materials requiremdnts, outputs, residuals, energy requirements, economic costs, and resource specific state and federal laws and regulations.

23669 EPA regulatory/research program. Thoem, T.; Christianson, A.; Harris, E.; Bates, E.; McCarthy, W. (Environmental Protection Agency, Washington, DC). pp 43-51 of Twelfth oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1979).

From 12. oil shale symposium; Golden, CO, USA (18 Apr 1979).

Legislation in the form of the Clean Air Act, the Clean Water Act, the Safe Drinking Water Act, and the Resource Conservation and Recovery Act provide the primary framework for regulations which control potential environmental impacts associated with oil shale development. Uncertainty over environmental requirements has been raised by some developers as a constraint to oil shale development. This paper attempts to dispel that notion. Results to date of EPA research programs conducted to characterize residuals from oil shale processes, to develop appropriate monitoring methodologies and to demonstrate mitigating pollution control practices are discussed. 6 figures.

23670 EPA Oil Shale Research/Regulatory Program. Thoem, T.L. (EPA Region VIII, Denver, CO); Harris, E.F. pp 1-9 of Eleventh oil shale symposium proceedings. Gary, J.H. (ed.). Golden, CO; Colorado School of Mines (1978).

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

This paper describes the EPA regulatory and research activities and the philosophy which bears upon the question of how large an oil shale industry, Colorado, Utah, and Wyoming can support. 17 tables. (DLC)

NUCLEAR FUELS

23671 (CONF-791185—3) **Overview of nuclear fuel cycle.** Blomeke, J.O. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 32p. NTIS, PC A03/MF A01.

From ANS student chapter seminar; College Station, TX, USA (5 Nov 1979).

A broad, general look is given at the fuel cycle from an overall perspective. Covered are: BWR and PWR fuel characteristics, U mining and milling, enrichment, fuel fabrication, spent fuel reprocessing, handling and shipment, etc. Results of the International Fuel Cycle Evaluation are summarized. (DLC)

23672 **Nuclear technology developments affecting uranium needs.** Morse, J.G. (Colorado School of Mines, Golden). pp 157-175 of Uranium resource/technology update: front end of the nuclear fuel cycle. Morse, J.G. (ed.). Golden, CO; Colorao School of Mines (1978).

From Uranium resource/technology update - front end of the nuclear fuel cycle; Golden, CO, USA (14 Mar 1978).

Focus of this paper is on the thorium fuel cycle as a potential or partial alternative to the uranium fuel cycle. Mention is also made of other factors which also impact the national uranium requirements: reprocessing, fast breeder reactors, enrichment plant performance, and process efficiencies. 5 figures, 5 tables.

RESERVES

23673 (GJBX—112(80)) **Probabilistic endowment appraisal system based upon the formalization of geologic decisions. General description.** Harris, D.P.; Carrigan, F.J. (Arizona Univ., Tucson (USA). Dept. of Mining and Geological Engineering). Apr 1980. Contract EY-76-C-13-1664. 106p. NTIS, PC A06/MF A01.

The objectives of this study include the design of an appraisal system which has the following features: estimates uranium endowment, not resources; formalizes the geologist's geoscience and assists the geologist in the exercise of his geoscience; describes the probability distribution for uranium endowment; diminishes or at least does not contribute to psychometric biases; provides for anonymous exchange among multiple experts of tenets of geoscience, but not the exchange of endowment estimates; provides an endowment estimate based upon geoscience only; is not easily gamed or manipulated; and provides for a quick and easy review of geoscience and resource information. This report is reflective of its title, a general description. The appraisal system resulting from this research is complex in the detail of its design and use. However, the major concepts which are reflected by the system are simple. The purpose of this report is to establish clearly these major concepts and the manner in which the system applies these concepts. Many details, refinements, and caveats are purposefully suppressed in order to provide this general description. While this suppression is a loss to some readers, it is a benefit to a wider spectrum of readers. Those interested in the nuts and bolts of the system will also want to read the user's manual which accompanies this general description.

23674 **Department of Energy's Uranium Resource Assessment activities.** Grutt, E.W. Jr. (Colorado School of Mines, Golden). pp 195-220 of Uranium resource/technology update: front end of the nuclear fuel cycle. Morse, J.G. (ed.). Golden, CO; Colorao School of Mines (1978).

From Uranium resource/technology update - front end of the nuclear fuel cycle; Golden, CO, USA (14 Mar 1978).

The Grand Junction Office of US DOE is involved in leasing of DOE-controlled lands, removal of uranium mill tailings, studies of former AEC-utilized sites, uranium production, and finally the National Uranium Resource Evaluation (NURE) survey. The NURE program is described in detail. 18 figures. (DLC)

EXPLORATION

23675 (GJBX—51(80)) **Great Divide Basin drilling project Sweetwater County, Wyoming.** Vizcaino, H.; Ferrell, P. (Bendix Field Engineering Corp., Grand Junction, CO (USA)). Apr 1980. Contract EY-76-C-13-1664. 35p. NTIS, PC A03/MF A01.

A six-hole drilling program conducted in the southeastern part of the Great Divide Basin, south-central Wyoming, obtained subsurface geologic data to evaluate the uranium potential of the Battle Spring Formation (Tertiary). In the Great Basin the formation consists of fluvial and lacustrine silstones, arkosic to feldspathic sandstones, and carbonaceous mudstones thought to contain intermediate-grade uranium (0.01 to 0.05% U_3O_8). Low-grade uranium mineralization is widespread throughout the area and generally occurs in carbonaceous mudstones interbedded with intercalated beds of coarse-grained sandstone and lignite. The close relationship between the permeability of the surrounding rocks and the uranium content of the carbonaceous units suggests that the uranium was epigenetically emplaced. All six of the drill holes penetrated thin intervals of intermediate-grade uranium mineralization.

23676 (GJBX—54(80)) **Thin, dipping ore zone logging models. Log studies.** Koizumi, C.J. (Bendix Field Engineering Corp., Grand Junction, CO (USA)). Mar 1980. Contract EY-76-C-13-1664. 50p. NTIS, PC A03/MF A01.

Thin, dipping mineralized zones are associated with a number of uranium deposits in various regions of the United States. In response to uncertainties about thin bed log interpretation, two thin, dipping ore zone logging models were constructed. Preliminary log studies with these models have established the following relation for gross gamma-ray logs of thin, dipping beds: $GT = KA \cos(\theta)$, where G = radiometric equivalent uranium grade, T = true zone thickness, K = probe calibration constant. A = area under zone response curve, and θ = dip angle of thin zone. For horizontal (θ = 0) thin beds, this expression is identical to the well-known relation for gross gamma-ray logs of thick horizontal zones: GT = KA. In resource mapping, the cos (θ) factor is applicable if resources are to be projected onto a plane that is parallel to the plane of the dipping mineralized zone. If mapping is to be done on a plane that is perpendicular to the borehole, then the appropriate expression is GT = KA, regardless of the dip angle. A satisfactory method has not been found for determining T in thin beds, whether inclined to the borehole or not.

23677 (GJBX—73(80)(Vol.1)) **Airborne gamma-ray spectrometer and magnetometer survey: Nulato quadrangle (Alaska). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Feb 1980. Contract EY-76-C-13-1664. 102p. NTIS, PC $8.50/MF $3.50.

During the months of July, August, and September 1979, an airborne high sensitivity gamma-ray spectrometer and magnetometer survey was carried out over ten 3° x 1° NTMS quadrangles of West-Central Alaska. The results obtained over the Nulato map area are discussed. The final data are presented in four different forms: on magnetic tape; on microfiche; in graphic form as profiles and histograms; and in map form as anomoly maps and flight path maps. The histograms and the multiparameter profiles are presented with the anomaly maps and flight path map in a separate volume.

23678 (GJBX—73(80)(Vol.2)) **Airborne gamma-ray spectrometer and magnetometer survey: Nulato quadrangle (Alaska). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Feb 1980. Contract EY-76-C-13-1664. 116p. NTIS, PC A06/MF A01.

Histograms, multiparameter profiles, anomaly maps, and flight path map from the airborne gamma-ray spectrometer and magnetometer survey over the Nulato quadrangle in Alaska are presented.

23679 (GJBX—79(80)(Vol.1)) **Airborne gamma-ray spectrometer and magnetometer survey: Sleetmute quadrangle (Alaska). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Mar 1980. Contract EY-76-C-13-1664. 99p. NTIS, PC $10.50/MF $3.65.

During the months of July, August, and September 1979 an airborne high sensitivity gamma-ray spectrometer and magnetometer survey was carried out over ten 3° x 1° NTMS quadrangles of West-Central Alaska. The results obtained over Sleetmute map are discussed. The final data are presented in four different forms: on magnetic tape; on microfiche; in graphic form as profiles and histograms; and in map form as anomaly maps, flight path maps, and computer printer maps. The histograms and the multiparameter profiles are presented with the anomaly maps and flight path map in a separate bound volume.

23680 (GJBX—79(80)(Vol.2)) **Airborne gamma-ray spectrometer and magnetometer survey: Sleetmute quadrangle (Alaska). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Mar 1980. Contract EY-76-C-13-1664. 110p. NTIS, PC A06/MF A01.

The histograms, multiparameter profiles, anomaly maps, and flight path map from the airborne gamma-ray spectrometer and magnetometer survey of the Sleetmute quadrangle of Alaska are presented.

23681 (GJBX—80-(80)(Vol.1)) **Airborne gamma-ray spectrometer and magnetometer survey: Iditarod quadrangle (Alaska). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Mar 1980. Contract EY-76-C-13-1664. 102p. NTIS, PC $10.50/MF $3.65.

During the months of July, August, and September 1979, an airborne high sensitivity gamma-ray spectrometer and magnetometer survey was conducted over ten 3° x 1° NTMS quadrangles of West-Central Alaska. The results obtained over the Iditarod map area are reported. The final data are presented in four different forms: on magnetic tape; on microfiche; in graphic form as profiles and histograms; and in map form as anomaly maps, flight path maps, and computer printer maps. The histograms and the multiparameter profiles are presented with the anomaly maps and flight path map in a separate volume. Anomalous radioactivity levels are encountered in mine locations on the Idatarod quadrangle, on both the uranium and thorium spectral windows. Three of these are relatively restricted, discrete anomalous features. The other six are in two groups of comparatively long intervals variably high in uranium and thorium series radiation, and they are aligned in such a manner as to suggest that their source is in a length zone or formation enriched in uranium and thorium mineralization.

23682 (GJBX—81(80)) **Mesa NTMS 1° x 2° quadrangle area. Supplemental data report.** Koller, G.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Jan 1980. Contract EY-76-C-13-1664. 61p. (DPST—80-146-15). NTIS, PC $8.50/MF $3.50.

This data report presents supplemental analytical results for stream sediments and ground water. The samples were collected as part of the SRL-NURE reconnaissance in the National Topographic Map Series (NTMS) Mesa 1° x 2° quadrangle. Results are reported for 24 elements (Ag, As, Ba, Be, Ca, Co, Cr, Cu, K, Li, Mg, Mo, Nb, Ni, P, Pb, Se, Sn, Sr, Th, W, Y, Zn, and extractable U) in sediments and 31 elements (Ag, Al, As, B, Ba, Be, Ca, Ce, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Sc, Se, Si, Sr, Th, Ti, V, Y, Zn, and Zr) as well as pH, alkalinity, and conductivity in ground water. Field data and NAA data will be open-filed when they are available. Microfiche cards have been placed in a pocket on the last page of this report. These cards contain the following information: Cards marked Pg. 1, Pg. 2, and Pg. 3 contain histograms, cumulative frequency plots, and areal distribution plots for sediment samples. The card marked Plate 1 is a site-code map for sediment samples.

23683 (GJBX—91(80)) **Challis 1° x 2° NTMS area Idaho: data report.** Thayer, P.A.; Cook, J.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). May 1980. Contract EY-76-C-13-1664. 111p. (DPST—80-146-5). NTIS, PC $12.50/MF $5.15.

This data report presents results of ground water and stream sediment reconnaissance in the National Topographic Map Series (NTMS) Challis 1° x 2° quadrangle. The target sampling density for all media collected was one site per 12 square kilometers. This resulted in 1428 sediment samples being collected; however, dry conditions and sparse population contributed to the relatively small number of surface water (208 samples) and ground water (229 samples) collected. Neutron activation analysis (NAA) results are given for uranium and 16 other elements in sediments, and for uranium and 9 other elements in ground water. Mass spectrometry results are given for helium in ground water. Field measurements and observations are reported for each site. Analytical data and field measurements are presented in tables and maps. Statistical summaries of data and a brief description of results are given. A generalized geologic map and a summary of the geology of the area are included. Data from ground water and stream water sites (on microfiche in pocket) include (1) water chemistry measurements (pH, conductivity, and alkalinity), (2) physical measurements (water temperature and scintillometer reading), and (3) elemental analyses (U, Al, Br, Cl, Dy, F, He, Mg, Mn, Na, and V). Data from sediment sites (also on microfiche in pocket) include (1) water chemistry measurements (pH, conductivity, and alkalinity), and (2) elemental analyses (U, Th, Hf, Al, Ce, Dy, Eu, Fe, La, Lu, Mn, Sc, Sm, Na, Ti, V, and Yb). Sample site descriptors (stream characteristics, vegetation, etc.) are also tabulated. Symbol plot maps, histograms, and cumulative frequency plots for most elements, U/Th and U/Hf ratios, and scintillometer readings are included on the microfiche.

23684 (GJBX—92(80)) **Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report.** (Texas Instruments, Inc., Dallas (USA)). Mar 1980. Contract EY-76-C-13-1664. 67p. NTIS, PC A04/MF A01.

Instrumentation and methods described were used for a Department of Energy (DOE) sponsored, high-sensitivity, aerial gamma-ray spectrometer and magnetometer survey of the contiguous Bluefield (Kentucky, Viriginia, West Virginia), Canton (Ohio, Pennsylvania, West Virginia), Charleston (Ohio, West Virginia), Charlottesville (Virginia, West Virginia), Chattanooga (North Carolina, Tennessee), Clarksburg, (Ohio, Pennsylvania, West Virginia), Corbin (Kentucky, Tennessee), Cumberland (Maryland, Pennsylvania, Virginia, West Virginia), Jenkins (Kentucky, Virginia, West Virginia), Roanoke (Virginia), and Rome (Alabama, Georgia), NTMS, 1:250,000 scale quadrangles. The objective of the work was to define areas showing surface indications of a generally higher uranium content where detailed exploration for uranium would most likely be successful. A Sikorsky S-58T aircraft equipped with a high-sensitivity gamma-ray spectrometer and ancillary geophysical and electronic equipment was employed for the quadrangle. The system was calibrated using the DOE calibration facilities at Grand Junction, Colorado, and Lake Mead, Arizona. Gamma-ray spectrometric data were processed to correct for variations in atmospheric, flight, and instrument conditions and were statistically evaluated to remove the effects of surface geologic variations. The resulting first-priority uranium anomalies (showing simultaneously valid eU, Eu/eTh, and eU/K anomalies) were interpreted to evaluate their origin and significance. Results of the interpretation in the form of a preferred-anomaly map, along with significance-factor profile maps, stacked profiles, histograms, and descriptions of the geology and known uranium occurrences are presented in the individual quadrangle volumes of this final report.

23685 (GJBX—95(80)) **Aerial radiometric and magnetic survey: Jordan Valley National Topographic Map, Idaho and Oregon. Rocky Mountain, 1979.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract AC13-76GJ01664. 394p. NTIS, PC $33.50/MF $17.30.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Jordan Valley National Topographic Map NK11-5 are presented. The airborne data gathered are reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included, with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

23686 (GJBX—96(80)(Vol.1)) **Aerial gamma ray and magnetic survey: Idaho Project, Nemo Detail Area, South Dakota. Final report.** (EG and G GeoMetrics, Sunnyvale, CA (USA)). Apr 1980. Contract AC13-76GJ01664. 66p. NTIS, PC A04/MF A01.

During the month of August, 1979, EG and G geoMetrics collected 148 miles of high sensitivity airborne radiometric and magnetic data in western South Dakota. Data were collected on tranverse lines 1/4 mile apart and on two tie lines approximately 2 miles apart in one detail area within the Rapid City 1° x 2° sheet. All data were fully reduced and interpretated by geoMetrics and presented in two volumes. A relative dearth of geologic information seems to exist in this area. Paleozoic and Precambrian sedimentary, metamorphic, and igneous rocks appear to cover most of the region of study. Paleozoic rocks are primarily confined to the eastern side. A wide variety of Precambrian rocks are present as mapped. In addition to the standard data presentations and processing procedures, the data were examined for anomalous uranium valves and mappable geochemical subunits using the radiometric and magnetic data. Principal component analysis was performed on the radiometric data using standard deviation subunits defined by BFEC.

23687 (GJBX—96(80)(Vol.2)) **Aerial gamma ray and magnetic survey: Idaho Project, Nemo Detail Area, South Dakota. Final report.** (EG and G GeoMetrics, Sunnyvale, CA (USA)). Apr 1980. Contract AC13-76GJ01664. 106p. NTIS, PC $8.50/MF $3.50.

The Nemo Detail area covers 40 square miles in the eastern portion of the Black Hills Uplift. The region's geology is a combination of Precambrian igneous and metamorphic rocks, and overlying Early Paleozoic sediments and metasediments. The Paleozoics cover most of the eastern half of the area. A total of 7 groups of samples in uranium window constitute anomalies as defined in Volume I. These anomalies occur in locales of relatively high uranium and thorium with respect to the balance of the detail area. Magnetic data show a wide range of gradients; but fail to show a significant degree of correlation with available geologic interpretations or the radiometric data. Only one geochemical unit was defined on the basis of the radiometric criteria set forth in Volume I.

23688 (GJBX—97(80)) **Investigations of the uranium potential along the Proterozoic unconformity in the Van Horn Areas, Texas. Final report.** Davidson, D.M. Jr. (Texas Univ., El Paso (USA). Dept. of Geological Sciences). Apr 1980. Contract EY-76-C-13-1664. 82p. NTIS, PC $8.15/MF $3.50.

A 350 km² area was examined and systematically sampled in the vicinity of Van Horn, Texas for purposes of assessing the potential for non-sandstone type uranium deposits in the Precambrian units exposed there. In addition, four anomalous areas previously identified in the NURE program were critically evaluated for resource potential. Over 300 rock samples were prepared and chemically analyzed for 30 elements, including U, Th, and K. Three areas rendered anomalous values of radioactive elements (3x to 10x background) and may be seriously considered as potential sites of Proterozoic-type uranium mineralization. Examination of anomalies related to the NURE program proved negative.

23689 (GJBX—99(80)) **Hydrogeochemical and stream sediment reconnaissance basic data for Dickinson NTMS Quadrangle, North Dakota.** (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 31 Mar 1980. Contract EY-76-C-13-1664. 593p. (K/UR—135). NTIS, PC $27.50/MF $3.50.

Results of a reconnaissance geochemical survey of the Dickinson Quadrangle, North Dakota are reported. Field and laboratory data are presented for 544 groundwater and 554 stream sediment samples. Statistical and areal distributions of uranium and possible uranium-related variables are displayed. A generalized geologic map of the survey area is provided, and pertinent geologic factors which may be of significance in evaluating the potential for uranium mineralization are briefly discussed. Interpretation of the groundwater data indicates that scattered localities in the central portion of the quadrangle appear most promising for uranium mineralization. High values of uranium in this area are usually found in waters of the Sentinel Butte and Tongue River Formations. Uranium is believed to be concentrated in the lignite beds of the Fort Union Group, with concentrations increasing with proximity to the pre-Oligocene unconformity. Stream sediment data indicate high uranium values distributed over the central area of the quadrangle. Uranium in stream sediments does not appear to be associated with any particular geologic unit and is perhaps following a structural trend.

23690 (GJBX—100(80)) **Hydrogeochemical and stream sediment detailed geochemical survey for Laramie Range, Wyoming.** Butz, T.R.; Mitchell, H.L.; Bard, C.S.; Helgerson, R.N.; Grimes, J.G. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 31 Mar 1980. Contract EY-76-C-13-1664. 693p. (K/UR—33). NTIS, PC $33.50/MF $3.50.

Results of a detailed geochemical survey of part of the eastern flank of the Laramie Range and the northwestern edge of the Denver Basin in southeastern Wyoming are reported. Field and laboratory data are presented for 163 groundwater and 800 stream sediment samples, and field radiometric data are presented for 103 rock samples. Statistical and areal distributions of uranium and possible uranium-related variables are displayed. A generalized geologic map of the survey area is provided, and pertinent geologic factors which may be of significance in evaluating the potential for uranium mineralization, are briefly discussed. Two general trends of high uranium values are indicated by groundwater analysis: one running north-northeast to south-southwest through the center of the survey area, the other occurring in the southeastern corner of the survey area. The uranium trends are both underlain predominantly by waters of the Miocene and Oligocene rocks, and are separated by an area with anomalous concentrations of potassium and silicon. Stream sediment data indicate that soluble uranium (U-FL) is highest in the Precambrian igneous and metamorphic rocks in the western portion of the survey area, with the highest 85th percentile values occurring in granites, with gneisses closely following.

23691 (GJBX—101(80)) **Aerial radiometric and magnetic survey: Phenix City National Topographic Map, Alabama/Georgia, Southeast US Project 1979.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract AC13-76GJ01664. 266p. NTIS, PC $22.50/MF $9.80.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Phenix City National Topographic Map NI16-12 are presented. The airborne data gathered are reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included, with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

23692 (GJBX—104(80)) **Aerial radiometric and magnetic survey: Adel National Topographic Map, Oregon, Rocky Mountain, 1979.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract AC13-76GJ01664. 292p. NTIS, PC $33.50/MF $19.25.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Adel National Topographic Map NK11-4 are presented. The airborne data gathered are reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included, with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

23693 (GJBX—106(80)) **Hydrogeochemical and stream sediment reconnaissance basic data for Marquette NTMS Quadrangle, Michigan.** (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 31 Mar 1980. Contract EY-76-C-13-1664. 512p. (K/UR—136). NTIS, PC $24.50/MF $3.50.

Results of a reconnaissance geochemical survey of the Marquette Quadrangle, Michigan are reported. Field and laboratory data are presented for 254 groundwater and 220 stream sediment samples. Statistical and areal distributions of uranium and possible uranium-related variables are displayed. A generalized geologic map of the survey area is provided, and pertinent geologic factors which may be of significance in evaluating the potential for uranium mineralization are briefly discussed. Groundwater data indicate that the most promising area for potential uranium mineralization occurs in the west central portion of the survey area which is predominantly underlain by Precambrian granitic gneiss. Other areas which might have potential are along the south shore of Lake Superior in the Jacobsville Sandstone in the western half of the quadrangle, and in an area in the southeastern corner of the quadrangle, which is underlain by a variety of Precambrian rocks. Stream sediment data indicate that the greatest potential for uranium mineralization occurs in the western third of the Marquette Quadrangle. Stream sediments related to granite-gneiss terranes, Middle Precambrain metasediments, and major unconformities were found to have the highest anomalous uranium values. In these sediments, above-background concentrations of cobalt, chromium, iron, lithium, nickel, and manganese appear to be associated with anomalously high concentrations of soluble uranium.

23694 (GJBX—107(80)) **Walker Lake 1° x 2° NTMS area California and Nevada: data report.** Fay, W.M.; Jones, P.L. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Mar 1980. Contract EY-76-C-13-1664. 691p. (DPST—79-146-13). NTIS, PC $33.50/MF $3.95.

This data report presents results of ground water and stream sediment reconnaissance in the National Topographic Map Series (NTMS) Walker Lake 1° x 2° quadrangle. Surface sediment samples were collected at 797 sites or at a nominal density of one site per 20 square kilometers (eight square miles). Ground water samples were collected at 77 sites or at a nominal density of one site per 220 square kilometers (87 square miles). Neutron activation analysis (NAA) results are given for uranium and 16 other elements in sediments, and for uranium and 8 other elements in ground water. Mass spectrometry results are given for helium in ground water. Field measurements and observations are reported for each site. Analytical data and field measurements are presented in tables and maps. Statistical summaries of data and a brief description of results are given. A generalized geologic map and a summary of the geology of the area are included. Data from ground water sites (on microfiche in pocket) include (1) water chemistry measurements (pH, conductivity, and alkalinity), (2) physical measurements (water temperature, well description, and scintillometer reading), and (3) elemental analyses (U, Al, Br, Cl, Dy, F, He, Mg, Mn, Na, and V). Data from sediment sites (also on microfiche in pocket) include (1) water chemistry measurements (pH, conductivity, and alkalinity), and (2) elemental analyses (U, Th, Hf, Al, Ce, Dy, Eu, Fe, La, Lu, Mn, Sc, Sm, Na, Ti, V, and Yb). Sample site descriptors (stream characteristics, vegetation, etc.) are also tabulatedn Symbol plot maps, histograms, and cumulative frequency plots for most elements, U/Th and U/Hf ratios, and scintillometer readings are included on the microfiche.

23695 (GJBX—108(80)) **Reno 1° x 2° NTMS area Nevada: data report.** Bennett, C.B. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Mar 1980. Contract EY-76-C-13-1664. 562p. (DPST—79-146-15). NTIS, PC $30.50/MF $5.45.

This data report presents results of ground water and stream sediment reconnaissance in the National Topographic Map Series (NTMS) Reno 1° x 2° quadrangle. Stream sediment samples were collected from small streams at 960 sites or at a nominal density of one site per 18 square kilometers (seven square miles). Neutron activation analysis (NAA) results are given for uranium and 16 other elements in sediments, and for uranium and 10 other elements in ground water and surface water. Mass spectrometry results are given for helium in ground water. Field measurements and observations

are reported for each site. Analytical data and field measurements are presented in tables and maps. Statistical summaries of data and a brief description of results are given. A generalized geologic map and a summary of the geology of the area are included. Data from ground water sites (on microfiche in pocket) include (1) water chemistry measurements (pH, conductivity, and alkalinity), (2) physical measurements (water temperature, well description, and scintillometer reading), and (3) elemental analyses (U, Al, Br, Cl, Dy, F, He, Mg, Mn, Na, and V). Data from sediment sites (also on microfiche in pocket) include (1) water chemistry measurements (pH, conductivity, and alkalinity), and (2) important elemental analyses (U, Th, Hf, Al, Ce, Dy, Eu, Fe, La, Lu, Mn, Sc, Sm, Na, Ti, V, and Yb). Sample site descriptors (stream characteristics, vegetation, etc.) are also tabulated. Symbol plot maps, histograms, and cumulative frequency plots for all the elements, U/Th and U/Hf ratios, and scintillometer readings are included on the microfiche.

23696 (LA—8321-PR) **NDA technology for uranium resource evaluation. Progress report, January 1-June 30, 1979.** Evans, M.L. (comp.). (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 35p. NTIS, PC A03/MF A01.

Calculational effort has focused on gamma-ray cross-section conversions, feasibility studies of an x-ray fluorescence (XRF) probe, and simulation of the prototype photoneutron logging tool. Experimental effort has concentrated on the design and fabrication of a field prototype photoneutron-based logging probe, on two types of borehole water monitors, and on a commercial pulse-shape discrimination unit to be used with the photoneutron logging probe. 37 figures, 4 tables.

23697 (LA-UR—80-1013) **Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States.** Bolivar, S.L. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 23p. (CONF-800465—2). NTIS, PC A02/MF A01.

From 8. international geochemical exploration symposium; Hanover, F.R. Germany (10 Apr 1980).

The Los Alamos Scientific Laboratory of the United States is conducting a geochemical survey for uranium in the Rocky Mountain states of New Mexico, Colorado, Wyoming, and Montana and in Alaska. This survey is part of a national hydrogeochemical and stream sediment reconnaissance in which four Department of Energy laboratories will study the uranium resources of the United States to provide data for the National Uranium Resource Evaluation program. The reconnaissance will identify areas having higher than background concentrations of uranium in ground waters, surface waters, and water-transported sediments. The reconnaissance data will be combined with data from airborne radiometric surveys and geological and geophysical investigations to provide an improved estimate for the economics and availability of nuclear fuel resources in the United States and to make information available to industry for use in the exploration and development of uranium resources. Water samples are analyzed for uranium by fluorometry which has a 0.02 parts per billion lower limit of detection. Concentrations of 12 additional elements in water are determined by plasma-source emission spectrography. All sediments are analyzed for uranium by delayed-neutron counting and a 20 parts per billion lower limit of detection. Elemental concentrations in sediments are also determined by neutron activation analysis, x-ray fluorescence, and by arc-source emission spectrography. To date, all of four Rocky Mountain states and about 80% of Alaska have been sampled. About 220,000 samples have been collected from an area of nearly 2,500,000 km^2. The philosophy, sampling methodology, analytical techniques, and progress of the reconnaissance are described in several published pilot study, reconnaissance, and technical reports. The Los Alamos program was designed to maximize the identification of uranium in terrains of varied geography, geology, and climate.

23698 **Uranium exploration.** De Voto, R.H. pp 1-83 of Uranium resource/technology update: front end of the nuclear fuel cycle. Morse, J.G. (ed.). Golden, CO; Colorao School of Mines (1978).

From Uranium resource/technology update - front end of the nuclear fuel cycle; Golden, CO, USA (14 Mar 1978).

This paper is a review of the methodology and technology currently being used in U exploration activities around the world. The bulk of the world's U has been produced historically from Lower Proterozoic uraninite placer deposits, epigenetic deposits in sandstones, and hydrothermal vein deposits. Exploration has been expanded to other geologic media such as granitic deposits, alkalic igneous-hydrothermal deposits, volcanic media, metamorphic-hydrothermal deposits, and calcrete deposits in deserts. U can also be recovered from syngenetic deposits in black shales and as a by-product in fertilizer production from phosphate rock. In-situ solution mining has been used to exploit low-grade deposits. Exploration techniques include geologic mapping, remote sensing, gamma-ray spectroscopy, geochemical surveys, radiometric surveys, radon and helium soil-gas surveys, stratigraphy, nonradiometric geophysical surveys, and drilling and logging. 52 references, 43 figures.

MINING

23699 **Solution mining of uranium.** Westphal, W.H. (Intercontinental Energy Corp., Englewood, CO). pp 84-102 of Uranium resource/technology update: front end of the nuclear fuel cycle. Morse, J.G. (ed.). Golden, CO; Colorao School of Mines (1978).

From Uranium resource/technology update - front end of the nuclear fuel cycle; Golden, CO, USA (14 Mar 1978).

The historical background of solution mining or in-situ leaching of U deposits is described briefly. Principles and operations of in-situ leaching are discussed. Geological and nongeological criteria for the application of in-situ leaching to a specific U deposit are set forth. Operational problems that still remain to be solved are described. (DLC)

FEED PROCESSING

REFER ALSO TO CITATION(S) 23632

23700 **Uranium recovery from wet-process phosphoric acid.** McCullough, J.F.; Phillips, J.F. Jr.; Tate, L.R. (to Tennessee Valley Authority). US Patent 4,180,545. 25 Dec 1979. Filed date 25 Aug 1977. 12p.

A method of recovering uranium from wet-process phosphoric acid is claimed where the acid is treated with a mixture of an ammonium salt or ammonia, a reducing agent, and then a miscible solvent. Solids are separated from the phosphoric acid liquid phase. The solid consists of a mixture of metal phosphates and uranium. It is washed free of adhering phosphoric acid with fresh miscible solvent. The solid is dried and dissolved in acid whereupon uranium is recovered from the solution. Miscible solvent and water are distilled away from the phosphoric acid. The distillate is rectified and water discarded. All miscible solvent is recovered for recycle. 5 claims.

23701 **Uranium milling.** Hazen, W. (Hazen Research, Inc., Golden, CO). pp 103-121 of Uranium resource/technology update: front end of the nuclear fuel cycle. Morse, J.G. (ed.). Golden, CO; Colorao School of Mines (1978).

From Uranium resource/technology update - front end of the nuclear fuel cycle; Golden, CO, USA (14 Mar 1978).

The historical development of the U milling industry is described. Flowsheets showing the material flow in U mills are included. The general drop in ore grade with time and the need for preconcentration are pointed out. Recent developments include thickeners, continuous ion exchange, U recovery from copper leaching operations and gold ore, resin in pulp recovery, etc. (DLC)

CENTRIFUGATION

REFER ALSO TO CITATION(S) 23758

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 24491

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 23714, 23717, 23759

23702 (PNL—3166(Pt.1)) **Cladding hull decontamination and densification process. Part 1. The prototype cladding hull decontamination system.** Lambright, T.M.; Montgomery, D.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract EY-76-C-06-1830. 56p. NTIS, PC A04/MF A01.

A prototype system for decontaminating Zircaloy-4 cladding hulls has been assembled and tested at Pacific Northwest Laboratory. The decontamination process consists of treatment with a gaseous mixture of hydrogen fluoride (HF) and argon (Ar) followed by a dilute aqueous etch of ammonium oxalate, ammonium citrate, ammonium fluoride, and hydrogen peroxide. The continuous cleaning process described in this report successfully descaled small portions of most charges, but was unable to handle the original design capacity of 4 kg/hr because of problems in the following areas: control of HF reactor temperatures, regulation of HF and argon mixtures and flows, isolation of the HF reactor atmosphere from the aqueous washer/rinser atmosphere, regulation of undesirable side reactions, and control over hull transport through the system. Due to the limited time available to solve these problems, the system did not attain fully operational status. The work was performed with unirradiated hulls that simulated irradiated hulls. The system was not built to be remotely operable. The process chemistry and system equipment are described in this report with

particular emphasis on critical operating areas. Recommendations for improved system operation are included.

23703 (PNL-SA—7844) **Kilogram-scale purification of americium by ion exchange.** Wheelwright, E.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1979. Contract EY-76-C-06-1830. 20p. (CONF-7910108—4). NTIS, PC A02/MF A01.

From Symposium on separation science and technology for energy applications; Gatlinburg, TN, USA (30 Oct 1979).

Sequential anion and cation exchange processes have been used for the final purification of ^{241}Am recovered during the reprocessing of aged plutonium metallurgical scrap. Plutonium was removed by absorption of Dowex 1, X-3.5 (30 to 50 mesh) anion exchange resin from 6.5 to 7.5 M HNO_3 feed solution. Following a water dilution to 0.75 to 1.0 M HNO_3, americium was absorbed on Dowex 50W, X-8 (50 to 100 mesh) cation exchange resion. Final purification was accomplished by elution of the absorbed band down 3 to 4 successive beds of the same resin, preloaded with Zn^{2+}, with an NH_4OH buffered chelating agent. The recovery of mixed ^{241}Am-^{243}Am from power reactor reprocessing waste has been demonstrated. Solvent extraction was used to recover a HNO_3 solution of mixed lanthanides and actinides from waste generated by the reprocessng of 13.5 tons of Shippingport Power Reactor blanket fuel. Sequential cation exchange band-displacement processes were then used to separate americium and curium from the lanthanides and then to separate ~ 60 g of ^{244}Cm from 1000 g of mixed ^{241}Am-^{243}Am.

23704 **Reprocessing nuclear fuels of the future: a radiological assessment of advanced (Th,U) carbide fuel.** Till, J.E.; Meyer, H.R.; Morse, L.E.; Bond, W.D.; Bomar, E.S.; Tennery, V.J. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **48**: No. 1, 54-62(Apr 1980).

The radiological dose associated with the use of (Th,U) carbide fuel in the core and thorium carbide in the blankets of a fast breeder reactor (FBR) was investigated. Analysis of the estimated dose due to reprocessing spent (Th,U) carbide fuel allows a direct comparison between the radiological consequences of the use of this fuel versus other candidates such as (U,Pu) oxide or carbide. Methodologies used were similar to those used in previous assessments of advanced FBR fuels. Results are calculated in terms of the potential dose commitment to a maximally exposed individual and to the general population living within 80 km of the operating plant. Tritium is found to be the principal contributor to dose commitment to total body for both the individual and the general population. Also contributing significantly to the dose are ^{14}C, ^{137}Cs, and ^{232}U. Maximum individual dose is 3.1 mrem (total body), while dose to total body for the population is found to be 39 man-rem per 50 GW(e)-yr. A parametric analysis conducted to determine the effect on dose of varying the ^{232}U content from 10 to 5000 ppM showed that at 5000 ppM $^{232}U/U$ and with no additional modification in the effluent treatment system, dose to the total body of a maximally exposed individual is increased by a factor of 1.4, from 2.8 to 4.0 mrem. Another analysis was conducted to determine the effect of increasing the reprocessing plant confinement factor for ^{3}H from 1 to 100. It was found that a confinement factor of 100 for ^{3}H reduces the dose to total body (for individuals and populations) by a factor of ~ 3. It is concluded that reprocessing of (Th,U) carbide fuel for FBRs should meet applicable standards in terms of radiological impact during routine operations. In this context, little difference is seen to exist between the (Th,U) carbide fuels and earlier results for (U,Pu) oxide and carbide fuels.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 23726, 24092, 24519

23705 (AGNS—47921-TPR-3) **AFR/design and licensing information/BNFP as a model. Technical progress report, January-March 1980.** (Allied-General Nuclear Services, Barnwell, SC (USA)). 25 Apr 1980. Contract AC09-79ET47921. 15p. NTIS, PC A02/MF A01.

Work on this project is focused on developing design and licensing information for the model facility. Three major subcontracts have been approved by DOE and the design effort is progressing satisfactorily on the security system, rack design, and the soils structural and seismic design which these contracts cover. Licensing activities are progressing satisfactorily. About 50% of the Environmental Report is drafted and issued for preliminary review. Approximately 15% of the Safety Analysis Report has been drafted.

23706 (DOE/ET/47906—4) **Reactivity monitoring. Final report, Task 2.** Reier, M.; Ching, J. (Nuclear Services Corp., Campbell, CA (USA)). 5 May 1980. Contract AC09-79ET47906. 26p. NTIS, PC A03/MF A01.

A study has been made of a pulsed neutron technique which can be used to estimate the reactivity worth of spent fuel assemblies prior to storage. Nuclear design has been performed of a subcritical facility which can accommodate a test assembly of fresh fuel as well as one with a high degree of burnup. Calculations include the k/sub eff/ of the system and the gamma shielding required to protect personnel and instrumentation from fission product radiation. In addition, the technique and relevant equations to analyze the data are discussed. The calculations indicate that the technique can provide a rough differentiation between assemblies based on reactivity. However, practical problems involving the shield and neutron source impose severe limitations on the use of this method.

23707 (DOE/SR—0004(Vol.1)) **Department of Energy study on spent nuclear fuel storage.** (Department of Energy, Washington, DC (USA)). Mar 1980. 47p. NTIS, PC A03/MF A01.

This report defines the needs for storage facilities and identifies possible sites in three regions of the US where such facilities could be located. The three sites are: Barnwell, South Carolina; Morris, Illinois; and West Valley, New York. This report includes consideration of the technical, economic, and regulatory factors associated with providing spent fuel storage in existing or potential at-reactor storage pools, and in AFR storage pools. This determination was based on specific data regarding the storage capacity needed to accommodate spent fuel from reactor pools by January 1, 1985, that the utilities would be unable to provide for themselves.

23708 (DOE/SR—0004(Vol.2)) **Appendices for Department of Energy study on spent nuclear fuel storage.** (Department of Energy, Washington, DC (USA)). Mar 1980. 92p. NTIS, PC A05/MF A01.

Eight appendices comprise this report: predicted away-from-reactor storage requirements; detailed cost information for at-reactor and away-from-reactor storage pools; spent fuel storage studies by federal agencies or interagencies; detailed site information; reactors with near term considerations; state legislation affecting siting of away-from-reactor storage; Department of Energy Act of 1978; and legislation affecting transportation to AFR facilities.

23709 (PNL—3171) **Spent fuel and fuel pool component integrity. Annual report, FY 1979.** Johnson, A.B. Jr.; Bailey, W.J.; Schreiber, R.E.; Kustas, F.M. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1980. Contract EY-76-C-06-1830. 86p. Dep. NTIS, PC A05/MF A01.

International meetings under the BEFAST program and under INFCE Working Group No. 6 during 1978 and 1979 continue to indicate that no cases of fuel cladding degradation have developed on pool-stored fuel from water reactors. A section from a spent fuel rack stand, exposed for 1.5 y in the Yankee Rowe (PWR) pool had 0.001- to 0.003-in.-deep (25- to 75-μm) intergranular corrosion in weld heat-affected zones but no evidence of stress corrosion cracking. A section of a 304 stainless steel spent fuel storage rack exposed 6.67 y in the Point Beach reactor (PWR) spent fuel pool showed no significant corrosion. A section of 304 stainless steel 8-in.-dia pipe from the Three Mile Island No. 1 (PWR) spent fuel pool heat exchanger plumbing developed a through-wall crack. The crack was intergranular, initiating from the inside surface in a weld heat-affected zone. The zone where the crack occurred was severely sensitized during field welding. The Kraftwerk Union (Erlangen, GFR) disassembled a stainless-steel fuel-handling machine that operated for 12 y in a PWR (boric acid) spent fuel pool. There was no evidence of deterioration, and the fuel-handling machine was reassembled for further use. A spent fuel pool at a Swedish PWR was decontaminated. The procedure is outlined in this report.

23710 (UCID—18660) **Advanced three-dimensional thermal modeling of a baseline spent fuel repository.** Altenbach, T.J.; Lowry, W.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Apr 1980. Contract W-7405-ENG-48. 55p. Dep. NTIS, PC A04/MF A01.

A three-dimensional thermal analysis using finite difference techniques was performed to determine the near-field response of a baseline spent fuel repository in a deep geologic salt medium. A baseline design incorporates previous thermal modeling experience and OWI recommendations for areal thermal loading in specifying the waste form properties, package details, and emplacement configuration. The base case in this thermal analysis considers one 10-year old PWR spent fuel assembly emplaced to yield a 36 kW/acre (8.9 W/m^2) loading. A unit cell model in an infinite array is used to simplify the problem and provide upper-bound temperatures. Boundary conditions are imposed which allow simulations to 1000 years. Variations studied include a comparison of ventilated and unventilated storage room conditions, emplacement packages with and without air gaps surrounding the canister, and room cool-down scenarios with ventilation following an unventilated state for retrieval purposes. It was found that at this low-power level, ventilating the emplacement room has an immediate cooling influence on the canister and effectively maintains the emplacement room floor near the temperature of the ventilating air.

MARKETING AND ECONOMICS

23711 Uranium resource/technology update: front end of the nuclear fuel cycle. Morse, J.G. (ed.). Golden, CO; Colorao School of Mines (1978). 230p. (CONF-7803123—).

From Uranium resource/technology update - front end of the nuclear fuel cycle; Golden, CO, USA (14 Mar 1978).

The seminar was an attempt to focus and develop perspectives vis-a-vis the exploration, mining, and milling; concerns for satisfying environmental requirements in these disciplines; capital needs of the growing industry; nuclear alternatives, such as the thorium cycle; and investment opportunities for those outside of this industry. Separate abstracts were prepared for all eight papers.

23712 Commercial development considerations. Curtin, M.S. (Colorado School of Mines, Golden). pp 133-156 of Uranium resource/technology update: front end of the nuclear fuel cycle. Morse, J.G. (ed.). Golden, CO; Colorao School of Mines (1978).

From Uranium resource/technology update - front end of the nuclear fuel cycle; Golden, CO, USA (14 Mar 1978).

Historically, electricity from a nuclear plant has been less expensive than that from a fossil-fuel plant. However, there are other, noneconomic factors that tend to discourage building nuclear power plants. Aside from uranium price and market considerations, other factors that influence the commercial development of a uranium property include estimated capital and operating costs, production lead time, and financial considerations. 8 tables. (DLC)

23713 Perspectives of the uranium industry. Bock, T.H. (Hanifen, Imhoff, and Samford, Inc., Denver, CO). pp 176-194 of Uranium resource/technology update: front end of the nuclear fuel cycle. Morse, J.G. (ed.). Golden, CO; Colorao School of Mines (1978).

From Uranium resource/technology update - front end of the nuclear fuel cycle; Golden, CO, USA (14 Mar 1978).

This paper discusses the factors that affect making investments in uranium. The characteristics of uranium as a commodity are enumerated. Supply and demand are discussed, and the importance of timing and prices is pointed out. Buyer-seller relationships and world market forces are also mentioned. (DLC)

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 25071

23714 (RHO-CD—883) Nuclear fuel services waste characterization and waste removal system. Smith, R.E. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Apr 1980. Contract AC06-77RL01030. 56p. NTIS, PC A04/MF A01.

The work covered by this DOE program is the key to providing necessary technical support to evaluate safety of continued in-tank storage and alternatives for final disposition of wastes at West Valley. The program has been scheduled to be performed as soon as feasibie, consistent with budget requirements for accuracy and safety.

WASTE PROCESSING

REFER ALSO TO CITATION(S) 23702, 23703, 23764

23715 (CONF-791112—63) Methods for separating actinides from reprocessing and refabrication plant wastes. Tedder, D.W.; Finney, B.C.; Blomeke, J.O. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 8p. NTIS, PC A02/MF A01.

From Symposium on the scientific basis for nuclear waste management; Boston, MA, USA (26 Nov 1979).

Chemical processing flowsheets have been developed to partition actinides from all actinide-bearing LWR fuel reprocessing and refabrication plant wastes. These wastes include high-activity-level liquids, scrap recovery liquors, HEPA filters and incinerator ashes, and chemical salt wastes such as sodium carbonate scrub solutions, detergent cleanup streams, and alkaline off-gas scrubber liquors. The separations processes that were adopted for this study are based on solvent extraction, cation exchange chromatography, and leaching with Ce^{4+}-HNO_3 solution.

23716 (DP—1540) Modeling principles applied to the simulation of a joule-heated glass melter. Routt, K.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). May 1980. Contract EY-76-C-09-0001. 47p. NTIS, PC A03/MF A01.

Three-dimensional conservation equations applicable to the operation of a joule-heated glass melter were rigorously examined and used to develop scaling relationships for modeling purposes. By rigorous application of the conservation equations governing transfer of mass, momentum, energy, and electrical charge in three-dimensional cylindrical coordinates, scaling relationships were derived between a glass melter and a physical model for the following independent and dependent variables: geometrical size (scale), velocity, temperature, pressure, mass input rate, energy input rate, voltage, electrode current, electrode current flux, total power, and electrical resistance. The scaling relationships were then applied to the design and construction of a physical model of the semiworks glass melter for the Defense Waste Processing Facility. The design and construction of such a model using glycerine plus LiCl as a model fluid in a one-half-scale Plexiglas tank is described.

23717 (DP-MS—80-39) High level nuclear waste. Crandall, J.L. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract AC09-DPSR00001. 40p. (CONF-800535—1). NTIS, PC A03/MF A01.

From ASME Idaho section symposium; Idaho Falls, ID, USA (29 May 1980).

The DOE Division of Waste Products through a lead office at Savannah River is developing a program to immobilize all US high-level nuclear waste for terminal disposal. DOE high-level wastes include those at the Hanford Plant, the Idaho Chemical Processing Plant, and the Savannah River Plant. Commercial high-level wastes, for which DOE is also developing immobilization technology, include those at the Nuclear Fuel Services Plant and any future commercial fuels reprocessing plants. The first immobilization plant is to be the Defense Waste Processing Facility at Savannah River, scheduled for 1983 project submission to Congress and 1989 operation. Waste forms are still being selected for this plant. Borosilicate glass is currently the reference form, but alternate candidates include concretes, calcines, other glasses, ceramics, and matrix forms.

23718 (ENICO—1026) Purification of dihexyl N,N-diethylcarbamylmethylenephosphonate by mercury (II) precipitation. Schroeder, N.C.; McIsaac, L.D.; Krupa, J.F. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). Jan 1980. Contract AC07-79ID01675. 16p. NTIS, PC A02/MF A01.

Dihexyl N,N-diethylcarbamylmethylenephosphonate (DHDECMP) is an important extractant for partitioning actinides from acidic nuclear waste solutions. A new technique for purifying DHDECMP is presented. Reaction of 20% crude DHDECMP in hexane with 1M mercuric nitrate at 40°C precipitates $Hg(DHDECMP)NO_3$. DHDECMP, liberated from the precipitate by treatment with caustic cyanide, is $>$ 95% jpure. The procedue is fast, inexpensive and has a high yield ($\sim$ 85%) compared to previous methods.

23719 (ENICO—1036) Role of seed particles in the prediction and control of product particle size in fluidized-bed dryers. Grimmett, E.S. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). Apr 1980. Contract AC07-79ID01675. 39p. Dep. NTIS, PC A03/MF A01.

Particle size distribution in a fluidized-bed dryer (where a solution is converted to a solid granular particle) depends on several different rate processes taking place. These include particle growth, particle attrition, product rate, feed deposition rate, elutriation rate, and seed attrition rate. While these rate processes are basic, depending on the material being dried, some become more important than others. Few new seed particles are generated within the bed when the physical properties of many materials being dried are such that little particle attrition takes place. Under these conditions, the particle size distribution in the bed continually increases unless some measure is taken to introduce into, or generate within the bed, new seed particles. This paper briefly describes the mathematical model which predicts the particle size distribution expected when drying solutions in a fluidized bed. The important role that seed particles play in determining the steady-state particle size distribution of the bed is stressed. An experiment is described in which information was obtained that helped determine what seed particles are, and what size particles became seeds.

23720 (LA-UR—80-1168) Plutonium recovery at the Los Alamos Scientific Laboratory. Christensen, E.L. (Los Alamos Scientific Lab., NM (USA)). Jun 1980. Contract W-7405-ENG-36. 27p. (CONF-800611—5). NTIS, PC A03/MF A01.

From International symposium on the management of alpha-contaminated wastes; Vienna, Austria (2 Jun 1980).

Portions of document are illegible.

Research programs have led to the adoption of procedures for all phases of plutonium recovery and purification. This report discusses some of the many procedures required to recover and purify the plutonium contained in the residues generated by LASL research, process development, and production activities. The report also discusses general plant facilities, the liquid and gaseous effluents, and solid waste management practices at the New Plutonium Facility, TA-55. Many of the processes or operations are merely steps in preparing the feed for one of the purification systems. For example, the plutonium is currently removed from noncombustibles in the pickling operation with an HNO_3 leach. The HNO_3 leach solution is the product of this operation and is sent to one of the nitrate anion-exchange systems for concentration and purification.

23721 (LA-UR—80-1265) **Performance and improvements of the tritium handling facility at the Los Alamos Scientific Laboratory.** Nasise, J.E. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 7p. (CONF-800427—10). NTIS, PC A02/MF A01.

From Tritium technology in fission, fusion, and isotopic application; Dayton, OH, USA (29 Apr 1980).

A major problem facing todays nuclear energy industry is the release of radioactive waste products to the atmosphere. The DP-East Tritium Handling Facility at the Los Alamos Scientific Laboratory (LASL), activated December 5, 1974 has processed 3.8 x 10^6 curies of tritium with a total stack release of 704.5 curies as of December 12, 1979. This averages only 11.7 Ci/month which to our knowledge is the lowest stack release any major tritium facility has achieved. The facility includes an 11.5 m^3 dry box with associated gas purification system (GPS) and an effluent treatment system (FTS). The system performance, problems, and improvements are discussed with special emphasis given to the ETS, the new dry box waste disposal system, and the new automated logic control system, all of which contribute significantly to the low level tritium release at this facility.

23722 (ORNL/TM—7371) **High-level waste program progress report, January 1, 1980-March 31, 1980.** (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 31p. NTIS, PC A03/MF A01.

FUETAP concretes cured at 100°C and 0.1 or 0.6 MPa had essentially the same physical properties as those cured at higher temperatures and pressures. Standard specimens containing high concentrations of ^{244}Cm showed little gasification after 1 month. The large (23-cm ID) spray calciner has been completed and is operating satisfactorily. Construction was completed on a sphere-forming system capable of producing 100-g batches of Synroc spheres by internal gelation, and several runs were made. Preparations for the compatibilty tests are underway. (DLC)

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 23707, 23708, 23710, 24654

23723 (DOE/EIS—0015(Vol.1)) **Final environmental impact statement: US Spent Fuel Policy. Executive summary.** (Department of Energy, Washington, DC (USA)). May 1980. 94p. NTIS, PC E03/MF E03.

The analysis of the environmental impacts for storage of domestic fuel shows that the impacts for the full range of alternatives considered are relatively small compared with available resources or background exposure of the population from natural radiation sources. The differences in impacts of storage of domestic fuel are attributed to the amount of fuel stored in Independent Spent Fuel Storage (ISFS) facilities, the storage time, and, to a lesser degree, the differences in spent fuel transportation. The differences between comparable alternatives of implementing the policy or not implementing the policy are small. The difference in impacts of storage of foreign fuel are attributed to the amount of fuel received under the policy and to the disposition mode analyzed. The impact of storage of foreign fuel (a small fraction of the amount of domestic fuel considered) is also small. As a result of the small differences in environmental impacts of all cases considered for foreign fuel, environmental impacts probably will not strongly influence the selection of the case that best meets US nonproliferation goals. Proliferation benefits of the various cases analyzed vary significantly. The structure and level of fee charged for storage of spent fuel will affect the degree of participation in the spent fuel storage program by utilities. However, the range of participation is within the range of alternatives analyzed in the draft EISs on storage of US and foreign fuels, for which the environmental effects were found to be relatively small. The fee computed on the basis of full recovery of government costs should not significantly affect the cost of generating nuclear power.

23724 (DOE/EIS—0015(Vol.2)) **Final environmental impact statement: US Spent Fuel Policy. Storage of US spent power reactor fuel.** (Department of Energy, Washington, DC (USA)). May 1980. 303p. NTIS, PC E05/MF E05.

The activities associated with implementing or not implementing the proposed policy are similar for a given disposition facility startup date, and environmental impacts vary with the amount of fuel received, the number of Interim Spent Fuel Storage (ISFS) facilities required, the storage time, and to a lesser degree to the amount of spent fuel transported. The environmental impacts from all alternatives considered, either from implementing or not implementing the spent fuel storage policy, are small. The decreased resource consumptions and environmental impacts of alternatives that assume reactor discharge basin operation at less than full-core reserve must be balanced against the reduced flexibility in reactor operation and the possibility of forced shutdowns which could lead to the use of higher-cost substitute power or reduction of electrical power generation. Providing full-core reserve capacity is prudent and economical to avoid reactor outages due to inspections or emergency situations. The impacts for decentralized ISFSs providing full-core reserve are considered the same for either government or private facilities. Nevertheless, utilities have operated without full-core reserve rather than shut down. At-reactor storage increases environmental effects compared with ISFS basin storage because additional storage basins are constructed and operated. However, the impacts are relatively small compared with available resources and risks from natural radiation sources.

23725 (DOE/EIS—0015(Vol.3)) **Final environmental statement: US Spent Fuel Policy. Storage of foreign spent power reactor fuel.** (Department of Energy, Washington, DC (USA)). May 1980. 227p. NTIS, PC E03/MF E03.

In October 1977, the Department of Energy (DOE) announced a Spent Fuel Storage Policy for nuclear power reactors. Under this policy, as approved by the President, US utilities will be given the opportunity to deliver spent fuel to US Government custody in exchange for payment of a fee. The US Government will also be prepared to accept a limited amount of spent fuel from foreign sources when such action would contribute to meeting nonproliferation goals. Under the new policy, spent fuel transferred to the US Government will be delivered - at user expense - to a US Government-approved site. Foreign spent fuel would be stored in Interim Spent Fuel Storage (ISFS) facilities with domestic fuel. This volume of the environmental impact statement includes effects associated with implementing or not implementing the Spent Fuel Storage Policy for the foreign fuels. The analyses show that there are no substantial radiological health impacts whether the policy is implemented or not. In no case considered does the population dose commitment exceed 0.000006% of the world population dose commitment from natural radiation sources over the period analyzed. Full implementation of the US offer to accept a limited amount of foreign spent fuel for storage provides the greatest benefits for US nonproliferation policy. Acceptance of lesser quantities of foreign spent fuel in the US or less US support of foreign spent fuel storage abroad provides some nonproliferation benefits, but at a significantly lower level than full implementation of the offer. Not implementing the policy in regard to foreign spent fuel will be least productive in the context of US nonproliferation objectives. The remainder of the summary provides a brief description of the options that are evaluated, the facilities involved in these options, and the environmental impacts, including nonproliferation considerations, associated with each option.

23726 (DOE/EIS—0015(Vol.4)) **Final environmental impact statement: US Spent Fuel Policy. Charge for spent fuel storage.** (Department of Energy, Washington, DC (USA)). May 1980. 104p. NTIS, PC E03/MF E03.

The United States Government policy relating to nuclear fuel reprocessing, which was announced by President Carter on April 7, 1977, provides for an indefinite deferral of reprocessing, and thus commits light water reactor (LWR) plants to a once-through fuel cycle during that indefinite period. In a subsequent action implementing that policy, the Department of Energy (DOE) on October 18, 1977 announced a spent fuel policy which would enable domestic, and on a selective basis, foreign utilities to deliver spent fuel to the US Government for interim storage and final geologic disposal, and pay the Government a fee for such services. This volume addresses itself to whether the fee charged for these services, by its level or its structure, would have any effect on the environmental impacts of implementing the Spent Fuel Policy itself. This volume thus analyzes the fee and various alternatives to determine the interaction between the fee and the degree of participation by domestic utilities and foreign countries in the proposed spent fuel program for implementing the Spent Fuel Policy. It also analyzes the effect, if any, of the fee on the growth of nuclear power.

23727 (DOE/EIS—0015(Vol.5)) **Final environmental impact statement: US Spent Fuel Policy. Comment letters on draft statements and major comments with DOE responses.** (Department of Energy, Washington, DC (USA)). May 1980. 496p. NTIS, PC E05/MF E05.

Notice of availability of the draft environmental impact statement for storage of US spent power reactor fuel was published by DOE in the Federal Register on September 6, 1978. A subsequent notice was published in the Federal Register on December 14, 1978, on the availability of the draft EISs on storage of foreign fuel, on charge for spent fuel storage, and a supplement to the draft EIS on storage of US fuel. Copies of the draft EISs were distributed for review and comment by appropriate Federal agencies, state governments, and other organizations and individuals who were known to have an interest in spent fuel storage activities and those who requested them. Comments and views concerning the draft EISs were requested from other interested agencies, organizations, and individuals by means of the Federal Register notices. Approximately 1600 copies each of the draft Domestic, Foreign, and Charge EISs were distributed for comment. The closing date for comments to be received on the draft EISs was February 15, 1979. Copies of the

EISs (upon publication) and comment letters received were placed for public inspection in DOE public document rooms at 10 locations throughout the country. To the extent practicable, comments received after the closing date were also considered in the preparation of the final EIS. A total of 78 comment letters (some with supplements) were received. These comment letters are reproduced in their entirety in Section I of this volume. Approximately 600 specific comments were identified in these letters.

23728 (DOE/NE—0005) **Spent fuel storage. Facts booklet.** (Department of Energy, Washington, DC (USA)). Apr 1980. 66p. NTIS, PC A04/MF A01.

In October 1977, the Department of Energy (DOE) announced a spent nuclear fuel policy where the Government would, under certain conditions, take title to and store spent nuclear fuel from commercial power reactors. The policy is intended to provide spent fuel storage until final disposition is available. DOE has programs for providing safe, long-term disposal of nuclear waste. The spent fuel storage program is one element of waste management and compliments the disposal program. The costs for spent fuel services are to be fully recovered by the Government from the utilities. This will allow the utilities to confidently consider the costs for disposition of spent fuel in their rate structure. The United States would also store limited amounts of foreign spent fuel to meet nonproliferation objectives. This booklet summarizes information on many aspects of spent fuel storage.

23729 (LA—8177) **Environmental sampling program for a solar evaporation pond for liquid radioactive wastes.** Romero, R.; Gunderson, T.C.; Talley, A.D. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 10p. NTIS, PC A02/MF A01.

Los Alamos Scientific Laboratory (LASL) is evaluating solar evaporation as a method for disposal of liquid radioactive wastes. This report describes a sampling program designed to monitor possible escape of radioactivity to the environment from a solar evaporation pond prototype constructed at LASL. Background radioactivity levels at the pond site were determined from soil and vegetation analyses before construction. When the pond is operative, the sampling program will qualitatively and quantitatively detect the transport of radioactivity to the soil, air, and vegetation in the vicinity. Possible correlation of meteorological data with sampling results is being investigated and measures to control export of radioactivity by biological vectors are being assessed.

23730 (LBL—10387) **Secondary minerals found in the cores DC2 A1 and DC2 A2 taken from the Grande Ronde Basalt Formation, Pasco Basin, Washington.** Teague, L.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1980. Contract W-7405-ENG-48. 36p. NTIS, PC A03/MF A01.

The results obtained for Task I are presented and discussed in this report. The subject of Task I is the study and identification of secondary mineral assemblages in two slant cores drilled off core DC2. The data were obtained from scanning electron microscopic (SEM/EDAX), x-ray diffraction (XRD), and thin section petrographic studies. In addition, an attempt was made to determine the lateral continuity of the secondary mineralization and the extent to which the fissures in this potential repository horizon were interconnected. Differences between the slant cores and DC2 may be due to variations in the vertical distribution of the samples and the fewer slant core samples studied. As a result, firm conclusions cannot be drawn regarding the depth dependence and relationship of mordenite precipitation to clinoptilolite dissolution. The limited data obtained in this and previous reports supports the preliminary conclusion that secondary mineralization is laterally continuous. Secondary mineral assemblages and morphologies in all cores are similar and no significant horizontal changes are observed.

23731 (LBL—10483) **Between-hole acoustic surveying and monitoring of a granitic rock mass.** Paulsson, B.N.P.; King, M.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1980. Contract W-7405-ENG-48. 19p. Dep. NTIS, PC A02/MF A01.

The purpose of this technical note is to present preliminary results of an acoustic monitoring study performed as part of a comprehensive rock mechanic and geophysics research program (Ref.20) associated with large-scale heater tests in an abandoned iron-ore mine in central Sweden. The investigation was performed in a fractured granitic rock mass at a sub-surface depth of 340 m, in a drift adjacent to the original iron-ore mine workings. Acoustic monitoring took place between four empty, dry, vertical boreholes of 10 m depth spaced in the vicinity of a vertical heater borehole in the floor of a drift.

23732 (ONWI—85) **Thermal gradient brine inclusion migration in salt study: gas-liquid inclusions, preliminary model.** Olander, D.R.; Machiels, A.J. (California Univ., Berkeley (USA)). Oct 1979. Contract EY-76-C-06-1830. 53p. Dep. NTIS, PC A04/MF A01.

Natural salt deposits contain small cubical inclusions of brine distributed through the salt. Temperature gradients, resulting from storing heat-generating wastes in the salt, can cause the inclusions to move through the salt. Prediction of the rate and amount of brine-inclusion migration is necessary for the evaluation of bedded or domed salts as possible media for waste repositories. Inclusions filled exclusively with liquid migrate up the temperature gradient towards the heat source. The solubility of salt in the brine inclusion increases with temperature. Consequently, salt dissolves into the inclusion across the hot surface and crystallizes out at the cold surface. Diffusion of salt within the liquid phase from the hot to the cold faces causes the inclusions to move in the opposite direction. In so doing, they change shape and eventually become rectangular parallelipipeds with a width (dimension perpendicular to the thermal gradient) much larger than the thickness (dimension in the direction of the thermal gradient). The inclusions may also contain a gas phase predominantly consisting of water vapor. These entities are termed two-phase or gas-liquid inclusions. The two-phase inclusions usually migrate down the temperature gradient away from the heat source remaining more-or-less cubical. A two-phase inclusion also forms when an all-liquid inclusion reaches the waste package; upon opening up at the salt-package interface, the brine partially evaporates and the inclusion reseals with some insoluble gas trapped inside. These gas-liquid inclusions proceed to move down the temperature gradient, in the opposite sense of the all-liquid inclusions. The gas-liquid inclusions phenomenon provides a pathway by which radionuclides leached from the wasteform by the brine can be transported away from the waste package and thus might have greater access to the biosphere. In this technical report, a detailed theory for migration of the two-phase inclusions is presented.

23733 (ORNL/SUB—80/13619/1) **Identification of technical problems encountered in the shallow land burial of low-level radioactive wastes.** Jacobs, D.G.; Epler, J.S.; Rose, R.R. (Oak Ridge National Lab., TN (USA)). Mar 1980. Contract W-7405-ENG-26. 187p. Dep. NTIS, PC A09/MF A01.

A review of problems encountered in the shallow land burial of low-level radioactive wastes has been made in support of the technical aspects of the National Low-Level Waste (LLW) Management Research and Development Program being administered by the Low-Level Waste Management Program Office, Oak Ridge National Laboratory. The operating histories of burial sites at six major DOE and five commercial facilities in the US have been examined and several major problems identified. The problems experienced st the sites have been grouped into general categories dealing with site development, waste characterization, operation, and performance evaluation. Based on this grouping of the problem, a number of major technical issues have been identified which should be incorporated into program plans for further research and development. For each technical issue a discussion is presented relating the issue to a particular problem, identifying some recent or current related research, and suggesting further work necessary for resolving the issue. Major technical issues which have been identified include the need for improved water management, further understanding of the effect of chemical and physical parameters on radionuclide migration, more comprehensive waste records, improved programs for performance monitoring and evaluation, development of better predictive capabilities, evaluation of space utilization, and improved management control.

23734 (ORO—5366-T2) **National Waste Terminal Storage repository in a bedded salt formation for spent unreprocessed fuel. Occupational exposure and health physics studies. KE report No. 78-21-R.** (Kaiser Engineers, Oakland, CA (USA)). Sep 1978. Contract EY-77-C-05-5366. 174p. NTIS, PC A08/MF A01.

This report includes the Occupational Exposure and Health Physics studies of the National Waste Terminal Storage Repository Number 2 (NWTSR2). Section 1 deals with occupational radiation exposures. The results of dose equivalent and dose commitment calculations are summarized. The man-rem total is a summation of all doses to all personnel throughout a year. It would have to be divided by the number of total personnel involved, to obtain an average annual dose per person. Section 2 presents the occupational exposures due to nonradiological pollutants. The activities of workers and the equipment used during the construction, storage/retrieval and decommissioning of the facility are outlined. Tabulations are presented of the substances (dusts, fumes, gases and vapors) and physical agents (heat, vibration, and nonionizing radiation) to which personnel will be exposed in various surface and underground work areas during construction and decommissioning, and during storage and retrieval operations. Some significant nonradiological occupational exposures are summarized. Section 3 outlines the health physics program for the NWTSR2 facility. It is important to initiate the health physics program one or two years before the facility is placed in operation to establish the radiation background levels at the site and its surrounding area, and to collect environmental samples, both on-site and off-site, prior to waste storage and retrieval operations. The health physics organization consists of 15 persons, including five health physicists.

23735 (PNL—2859) **Preliminary subsurface hydrologic considerations: Columbia River Plateau Physiographic Province. Assessment**

of effectiveness of geologic isolation systems. Veatch, M.D. (Battelle Pacific Northwest Labs., Richland, WA (USA); Shannon and Wilson, Inc., Seattle, WA (USA)). Apr 1980. Contract EY-76-C-06-1830. 43p. NTIS, PC A03/MF A01.

This report contains a discussion of the hydrologic conditions of the Columbia River Plateau physiographic province. The Columbia River Plateau is underlain by a thick basalt sequence. The Columbia River basalt sequence contains both basalt flows and sedimentary interbeds. These sedimentary interbeds, which are layers of sedimentary rock between lava flows, are the main aquifer zones in the basalt sequence. Permeable interflow zones, involving the permeable top and/or rubble bottom of a flow, are also water-transmitting zones. A number of stratigraphic units are present in the Pasco Basin, which is in the central part of the Columbia River Plateau. At a conceptual level, the stratigraphic sequence from the surface downward can be separated into four hydrostratigraphic systems. These are: (1) the unsaturated zone, (2) the unconfined aquifer, (3) the uppermost confined aquifers, and (4) the lower Yakima basalt hydrologic sequence. A conceptual layered earth model (LEM) has been developed. The LEM represents the major types of porous media (LEM units) that may be encountered at a number of places on the Columbia Plateau, and specifically in the Pasco Basin. The conceptual LEM is not representative of the actual three-dimensional hydrostratigraphic sequence and hydrologic conditions existing at any specific site within the Columbia Plateau physiographic province. However, the LEM may be useful for gaining a better understanding of how the hydrologic regime may change as a result of disruptive events that may interact with a waste repository in geologic media.

23736 (PNL—2862) **Assessment of effectiveness of geologic isolation systems: the feasibility of computer interrogation of experts for WISAP.** Wight, L.H. (Battelle Pacific Northwest Labs., Richland, WA (USA); TERA Corp., Berkeley, CA (USA)). May 1980. Contract EY-76-C-06-1830. 101p. NTIS, PC A06/MF A01.

Simulation of the response of a waste repository to events that could initiate a fault tree to breach and failure is currently a keystone to the Battelle Waste Isolation Safety Assessment Program (WISAP). The repository simulation, which is part of the Disruptive Event Analysis Task, models the repository for its entire design life, one million years. This is clearly a challenging calculation, requiring input unlike any other response analysis by virtue of the long design life of the facility. What technology will provide design criteria for a million year design life. Answers to questions like this can, to some extent, be based on data, but always require some subjective judgments. The subjectivity, which is sometimes driven by inadequate or incomplete data or by a lack of understanding of the physical process, is therefore a crucial ingredient in an analysis of initiating events. Because of the variety of possible initiating events (glaciation, man-caused disruption, volcanism, etc.), many expert opinions will be solicited as input. The complexity of the simulation, the variety of experts involved, and the volume of applicable data all suggest that there may be a more direct, economical method to solicit the expert opinion. This report addresses the feasibility of such a system. Background information is presented that demonstrates the advantages of a computer interrogation system over conventional interrogation and assessment techniques. In the subsequent three sections the three elements - structure and decomposition, scaling, and synthesis - that are basic to any interrogation and assessment technique are reviewed. The interrelationship are schematically illustrated between these three fundamental elements and, therefore, serves as a useful guide to these three sections. Each of these three sections begins with a recommended approach to the particular element and ends with an illustration of representative dialogue.

23737 (PNL—2874) **Waste Isolation Safety Assessment Program. Technical progress report for FY-1978.** Brandstetter, A.; Harwell, M.A.; Howes, B.W.; Benson, G.L.; Bradley, D.J.; Raymond, J.R.; Serne, R.J.; Schilling, A.H. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jul 1979. Contract EY-76-C-06-1830. 338p. NTIS, PC A15/MF A01.

Associated with commercial nuclear power production in the United States is the generation of potentially hazardous radioactive wastes. The Department of Energy (DOE) is seeking to develop nuclear waste isolation systems in geologic formations that will preclude contact with the biosphere of waste radionuclides in concentrations which are sufficient to cause deleterious impact on humans or their environments. Comprehensive analyses of specific isolation systems are needed to assess the expectations of meeting that objective. The Waste Isolation Safety Assessment Program (WISAP) has been established at the Pacific Northwest Laboratory (operated by Battelle Memorial Institute) for developing the capability of making those analyses. Progress on the following tasks is reported: release scenario analysis, waste form release rate analysis, release consequence analysis, sorption-desorption analysis, and societal acceptance analysis. (DC)

23738 (PNL—3318) **Materials Characterization Center workshop on leaching of radioactive waste forms. Summary report.** Ross, W.A.; Strachan, D.M.; Turcotte, R.P.; Westsik, J.H. Jr. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract EY-76-C-06-1830. 104p. Dep. NTIS, PC A06/MF A01.

At the first Materials Characterization Center (MCC) workshop, on the leaching of radioactive waste forms, there was general agreement that, after certain revisions, the proposed leach test plan set forth by the MCC can be expected to meet most of the nuclear waste community's waste form durability data requirements. The revisions give a clearer definition of the purposes of each test and the end uses of the data. As a result of the workshop, the format of the test program has been recast to clarify the purposes, limitations, and interrelationships of the individual tests. There was also a recognition that the leach test program must be based on an understanding of the mechanistic principles of leaching, and that further study is needed to ensure that the approved data from the MCC leach tests will be compatible with mechanistic research needs. It was agreed that another meeting of the participants in Working Groups 3 and 4, and perhaps some other experts, should be held as soon as possible to focus just on the definition of leach test requirements for mechanistic research. The MCC plans to hold this meeting in April 1980. Many of the tests that will lead to increased understanding of mechanisms will of necessity be long-term tests, sometimes lasting for several years. But the MCC also faces pressing needs to produce approved data that can be used for the comparison of waste forms in the relative near-term, i.e., in the next 1 to 3 yr. Therefore, it was decided to initiate a round-robin test of the MCC short-term static leach procedure as soon as practicable. The MCC has tentative plans for organization of the round robin in May 1980.

23739 (RHO-BWI-C—59) **Bibliography of the geology of the Columbia Basin and surrounding areas of Washington.** Tucker, G.B.; Rigby, J.G. (Washington State Dept. of Natural Resources, Olympia (USA)). Jul 1979. Contract AC06-77RL01030. 543p. NTIS, PC A23/MF A01.

In the fall of 1977, the Washington State Department of Natural Resources, Division of Geology and Earth Resources (WDGER), entered into a contract with the US Department of Energy, administered by Rockwell Hanford Operations (Rockwell) in Richland, Washington, as a principal contributor to a geologic study of feasibility of storing radioactive waste within Columbia River basalt. WDGER's responsibility was the production of this bibliography and a reconnaissance geologic map of the sediments overlying the Columbia River Basalt Group in the State of Washington. This bibliography is a compilation of all known published, unpublished, and open-file references dealing with geology and geophysics of the Columbia Basin of eastern Washington. The citations were obtained primarily from the WDGER and Washington State libraries; the Geo-Ref bibliographic system was also utilized. Because the WDGER portion of the study included preparation of a reconnaissance geologic map of surficial deposits in the Columbia Basin, available references dealing with this subject have been annotated. Many abstracts in the annotated section are quotations and have been copied directly from their respective publications.

23740 (RHO-SA—155) **Sorption studies at Hanford for the control of radioactive wastes.** Routson, R.C.; Barney, G.S.; Smith, R.M. (Rockwell International Corp., Richland, WA (USA). Energy Systems Group). Jan 1980. Contract EY-77-C-06-1030. 15p. (CONF-800607—31). Dep. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

Since 1944, the Hanford Site has been a location for the storage and disposal of radioactive wastes, nuclear reactor operations, and the chemical separations of nuclear materials. These activities resulted in the storage and disposal of fission products and low-level transuranic (TRU) radioactive wastes in the near future sediments above the water table. With the scale-down of Hanford reactor operations and fuel separation activities after 1967, increased emphasis was placed on waste management activities. Assessment of future impact of past Hanford operations required the development and verification of transport sorption models to make such assessments. Present Hanford sorption models and current studies for the sorption of strontium, cesium, and cobalt on the sediments of the Hanford Separation Areas based on a waste property/areal site-specific measurement concept are discussed.

23741 (SAND—79-0278) **Basic data report for Drillhole WIPP 22 (Waste Isolation Pilot Plant, WIPP).** (Sandia Labs., Albuquerque, NM (USA); Geological Survey, Albuquerque, NM (USA)). Mar 1980. Contract AC04-76DP00789. 72p. NTIS, PC A04/MF A01.

WIPP 22 is an exploratory borehole whose objective is to determine the nature of the near-surface formations after seismic information indicated a possible fault. The borehole is located in section 20, T.22S., R.31E., in eastern Eddy County, New Mexico, and was drilled between March 14 and 30, 1978. The hole was drilled to a depth of 1448 feet and encountered, from top to bottom,

surficial Holocene deposits (6', including artificial fill for drill pad), the Mescalero caliche (7'), the Santa Rosa Sandstone (68'), the Dewey Lake Red Beds (492'), the Rustler Formation (311'), and the upper portion of the Salado Formation (565'). Cuttings were collected at 10-foot intervals. A suite of geophysical logs was run to measure acoustic velocities, density, and radioactivity. On the basis of comparison with other geologic sections drilled in the area, the WIPP 22 section is a normal stratigraphic sequence and it does not show structural disruption. The WIPP is to demonstrate (through limited operations) disposal technology for transuranic defense wastes. The WIPP will also provide facilities to research interactions between high-level waste and salt.

23742 (SAND—79-1278) **Pretest thermal analysis of the Tuff Water Migration/In-Situ Heater Experiment.** Bulmer, B.M. (Sandia Labs., Albuquerque, NM (USA)). Feb 1980. Contract AC04-76DP00789. 43p. NTIS, PC A03/MF A01.

This report describes the pretest thermal analysis for the Tuff Water Migration/In-Situ Heater Experiment to be conducted in welded tuff in G-tunnel, Nevada Test Site. The parametric thermal modeling considers variable boiling temperature, tuff thermal conductivity, tuff emissivity, and heater operating power. For nominal tuff properties, some near field boiling is predicted for realistic operating power. However, the extent of boiling will be strongly determined by the ambient (100% water saturated) rock thermal conductivity. In addition, the thermal response of the heater and of the tuff within the dry-out zone (i.e., bounded by boiling isotherm) is dependent on the temperature variation of rock conductivity as well as the extent of induced boiling.

23743 (SAND—80-0359C) **Strategy for evaluating the long-term stability of hole-plugging materials in their geological environments.** Lambert, S.J. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 11p. (CONF-800527—2). Dep. NTIS, PC A02/MF A01.

From International BHP symposium; Columbus, OH, USA (7 May 1980).

Material used to plug boreholes will not in general be in chemical equilibrium with its host rock. Adverse long-term performance of a plug can involve changes in phase assemblage in the plug/rock system which are difficult to observe at low temperatures in real time. The thermodynamics of multiphase equilibria provides a technique of predicting what phase changes might occur. The thermodynamic treatment of plug/rock systems utilizes (1) a formulation of possible chemical reactions among phases in the system and (2) determinations of changes in values of Gibbs' free energies for the hypothetical reactions, to identify the theoretically-permitted reactions which could degrade plug performance. Time-dependent prediction of phase changes requires a knowledge of rate laws and constants for specific reactions whose mechanisms are well known.

23744 (SAND—80-0502C) **Role of borehole plugging in the evaluation of the Waste Isolation Pilot Plant.** Hunter, T.O. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 20p. (CONF-800527—3). Dep. NTIS, PC A02/MF A01.

From International BHP symposium; Columbus, OH, USA (7 May 1980).

Research on borehole plugging (BHP) is part of an integrated strategy to develop technology that can assure successful nuclear waste isolation. The application of this strategy to the Waste Isolation Pilot Plant (WIPP) in southeastern New Mexico has included an assessment of the role BHP plays in the development of a repository at that site. This paper presents a description of the WIPP site, repository design, and the current research and development program. The status of drill holes - those drilled for petroleum and potash exploration and those drilled for site characterization - within the proposed site boundaries is presented. Sixty-six holes are present on the 7700 hectare (19,000 acre) site, yet only 8 penetrate as deep as the proposed repository location. The assumptions made about shaft and borehole sealing in consequence assessment studies are presented. The results of these studies indicate that borehole seals with effective permeabilities greater than tens of darcies would result in doses to maximally exposed individuals of less than 0.01% of natural background.

23745 (SAND—80-1020/1) **Prediction of ground motion from underground nuclear weapons tests as it relates to siting of a nuclear waste storage facility at NTS and compatibility with the weapons test program.** Vortman, L.J. IV. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1980. Contract EY-76-C-04-0789. 44p. NTIS, PC A03/MF A01.

This report assumes reasonable criteria for NRC licensing of a nuclear waste storage facility at the Nevada Test Site where it would be exposed to ground motion from underground nuclear weapons tests. Prediction equations and their standard deviations have been determined from measurements on a number of nuclear weapons tests. The effect of various independent parameters on standard deviation is discussed. That the data sample is sufficiently large is shown by the fact that additional data have little effect on the standard deviation. It is also shown that coupling effects can be separated out of the other contributions to the standard deviation. An example, based on certain licensing assumptions, shows that it should be possible to have a nuclear waste storage facility in the vicinity of Timber Mountain which would be compatible with a 700 kt weapons test in the Buckboard Area if the facility were designed to withstand a peak vector acceleration of 0.75 g. The prediction equation is a log-log linear equation which predicts acceleration as a function of yield of an explosion and the distance from it.

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23747 (UCID—18651) **Application of FRAMIS to K/sub D/ data.** Storch, N. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Mar 1980. Contract W-7405-ENG-48. 25p. NTIS, PC A02/MF A01.

This report documents an application of the FRAMIS relational data base management system. A geochemical data base of ion exchange distribution coefficients (K/sub D/) is created and maintained by using very simple commands. Reports are automatically generated. Familiarity with the LLL Octopus Time-Sharing System and FRAMIS is assumed.

23748 (UCID—18664) **Review of geochemical measurement techniques for a nuclear waste repository in bedded salt.** Knauss, K.G.; Steinborn, T.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 May 1980. Contract W-7405-ENG-48. 72p. NTIS, PC A04/MF A01.

A broad, general review is presented of geochemical measurement techniques that can provide data necessary for site selection and repository effectiveness assessment for a radioactive waste repository in bedded salt. The available measurement techniques are organized according to the parameter measured. The list of geochemical parameters include all those measurable geochemical properties of a sample whole values determine the geochemical characteristics or behavior of the system. For each technique, remarks are made pertaining to the operating principles of the measurement instrument and the purpose for which the technique is used. Attention is drawn to areas where further research and development are needed.

23749 (UCID—18665) **Remarks on the assessment, representation, aggregation and utilization of expert opinion.** Fine, T.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1980. Contract W-7405-ENG-48. 42p. NTIS, PC A03/MF A01.

This report considers the relevance of recent ideas in the foundations of probability to the rational use of expert opinion in the design of a nuclear waste repository, and the assessment of its performance. The main probability concepts introduce are those of modal (probably A), comparative (A is at least as probable as B) and interval-valued (the lower probability of A is P(A) and the upper probability of A is P(anti A)) probabilities. We then outline an approach first using comparative probability to model the resuls of binary elicitation of an expert's opinions concerning repository uncertainties and then employing interval-valued probability to represent comparative probability in a computationally convenient form. We further consider the issue of aggregating or amalgamating the responses of several experts, and we emphasize the need to preserve some measure of the disagreements among the experts. The resulting aggregated interval-valued representation of the responses concerning the uncertainties surrounding the performance of a nuclear waste repository design can then be used to numerically assess this performance in a manner parallel to that of utility theory. Utility theory is the basis for statistical decision theory. Our recommendations can only be tentative, and research is recommended to gain some working experience with the results of the proposed decision-making process in the repostory design context.

23750 (UCRL—15228) **Conceptual design of retrieval systems for emplaced transuranic waste containers in a salt bed depository. Final report.** Fogleman, S.F. (International Engineering Co., Inc., San Francisco, CA (USA)). Apr 1980. Contract W-7405-ENG-48. 110p. Dep. NTIS, PC A06/MF A01.

The US Department of Energy and the Nuclear Regulatory Commission have jurisdiction over the nuclear waste management program. Design studies were previously made of proposed repository site configurations for the receiving, processing, and storage of nuclear wastes. However, these studies did not provide operational designs that were suitable for highly reliable TRU retrieval in the deep geologic salt environment for the required 60-year period. The purpose of this report is to develop a conceptual design of a baseline retrieval system for emplaced transuranic waste containers in a salt bed depository. The conceptual design is to serve as a working model for the analysis of the performance available from the current state-of-the-art equipment and systems. Suggested regulations would be based upon the results of the performance analyses.

23751 (UCRL—15229) **Transuranic contaminated waste functional definition and implementation.** Kniazewycz, B.G. (TERA Corp., Berkeley, CA (USA)). Mar 1980. Contract W-7405-ENG-48. 157p. Dep. NTIS, PC A08/MF A01.

The purpose of this report is to examine the problem(s) of TRU waste classification and to document the development of an easy-to-apply standard(s) to determine whether or not this waste package should be emplaced in a geologic repository for final disposition. Transuranic wastes are especially significant because they have long half-lives and some are rather radiotoxic. Transuranic radionuclides are primarily produced by single or multiple neutron capture by U-238 in fuel elements during the operation of a nuclear reactor. Reprocessing of spent fuel elements attempts to remove plutonium, but since the separation is not complete, the resulting high-activity liquids still contain some plutonium as well as other transuranics. Likewise, transuranic contamination of low-activity wastes also occurs when the transuranic materials are handled or processed, which is primarily at federal facilities involved in R and D and nuclear weapons production. Transuranics are persistent in the environment and, as a general rule, are strongly retained by soils. They are not easily transported through most food chains, although some reconcentration does take place in the aquatic food chain. They pose no special biological hazard to humans upon ingestion because they are weakly absorbed from the gastrointestional tract. A greater hazard results from inhalation since they behave like normal dust and fractionate accordingly.

23752 (UCRL—15232) **Monitoring system specifications: retrieval of surf from a salt repository.** (EA and T Co., Inc., Marina del Rey, CA (USA)). Jan 1980. Contract W-7405-ENG-48. 87p. Dep. NTIS, PC A05/MF A01.

The task of developing specifications for a reference monitoring system determined by repository environmental conditions, retrieval operations, and federal regulatory criteria is discussed. The monitoring system specified in this report is capable of measuring (1) package position and orientation, (2) vault deformation, (3) brine accumulation, (4) spent fuel dissolution, (5) temperature, (6) nuclear radiation, and (7) package condition with sufficient accuracy to provide data input to a general risk assessment model. In order to define a monitoring system which can provide probabilistic data on radiological risk to operating personnel and the general public for a salt mine repository, the following information is required: (1) a complete design of the salt SURF repository including inventory, density and waste package design details; (2) probalistic failure rate data on containment integrity of the SURF waste package; (3) probabilistic failure rate data on the monitoring system components (i.e., monitoring procedure, instrumentation, data acquisition, data processing and data interpretation).

23753 **Gas generation by self-radiolysis of tritiated waste materials.** Tadlock, W.E.; Abell, G.C.; Steinmeyer, R.H. (Monsanto Research Corp., Miamisburg, OH). Contract DE-AC-4-76-DP00053. *Nucl. Technol.;* 47: No. 2, 358-362(Feb 1980).

Studies simulating the effect of self-radiolysis in disposal packages containing tritiated waste materials show hydrogen to be the dominant gas-phase product. Pressure buildup and gas composition over various tritiated octane and tritiated water samples are designed to give worst case results. One effect of tritium fixation agents is to reduce pressure buildup. The results show that development of explosive gas mixtures is unlikely and that maximum pressure buildup in typical Mound Facility waste packages can be expected to be <0.25 MPa.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 23723, 23724, 23725, 23727, 23729, 23747

23754 (SAND—78-1331) **State policies and requirements for management of uranium mining and milling in New Mexico. Volume II. Water availability in the San Juan Structural Basin.** Vandevender, S.G. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 111p. NTIS, PC A06/MF A01.

This volume contains Two parts: Part One is an analysis of an issue paper prepared by the office of the New Mexico State Engineer on water availability for uranium production. Part Two is the issue paper itself. The State Engineer's report raises the issue of a scarce water supply in the San Juan Structural Basin acting as a constraint on the growth of the uranium mining and milling industry in New Mexico. The water issue in the structural basin is becoming an acute policy issue because of the uranium industry's importance to and rapid growth within the structural basin. Its growth places heavy demands on the region's scarce water supply. The impact of mine dewatering on water supply is of particular concern. Much of the groundwater has been appropriated or applied for. The State Engineer is currently basing water rights decisions upon data which he believes to be inadequate to determine water quality and availability in the basin. He, along with the USGS and the State Bureau of Mines and Mineral Resources, recommends a well drilling program to acquire the additional information about the groundwater characteristics of the basin. The information would be used to provide input data for a computer model, which is used as one of the bases for decisions concerning water rights and water use in the basin. The recommendation is that the appropriate DOE office enter into discussions with the New Mexico State Engineer to explore the potential mutual benefits of a well drilling program to determine the water availability in the San Juan Structural Basin.

23755 **Environmental problems of the uranium mining and milling industry.** Savignac, N. (United Nuclear Corp., Albuquerque, NM). pp 122-132 of Uranium resource/technology update: front end of the nuclear fuel cycle. Morse, J.G. (ed.). Golden, CO; Colorao School of Mines (1978).

From Uranium resource/technology update - front end of the nuclear fuel cycle; Golden, CO, USA (14 Mar 1978).

The environmental impacts (resources committed, radioactive and nonactive effluents, radioactive sources for population exposures) are compared for oil, coal, and U, using 100-MW(e) plants operating at 75% capacity as basis. Results show that U as a source of energy costs less, uses less resources, and has less environmental impact than oil or coal. A general sampling and monitoring program is presented. 8 tables. (DLC)

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 23704, 23734, 24654

23756 (CONF-791203—9) **Proposed training program for construction personnel involved in remedial action work at sites contaminated by naturally occurring radionuclides.** Berven, B.A.; Goldsmith, W.A.; Haywood, F.F.; Schiager, K.J. (Oak Ridge National Lab., TN (USA); ALARA, Inc., Lyons, CO (USA)). 1979. Contract W-7405-ENG-26. 11p. Dep. NTIS, PC A02/MF A01.

From Health Physics Society meeting; Honolulu, HI, USA (10 Dec 1979).

Many sites used during the early days of the US atomic energy program are contaminated with radionuclides of the primordial decay chains (uranium, thorium, and actinium series). This contamination consists of residues resulting from refining and processing uranium and thorium. Preparation of these sites for release to unrestricted private use will involve the assistance of construction workers, many of whom have limited knowledge of the hazards associated with radioactive materials. Therefore, there is a need to educate these workers in the fundamentals of radioactive material handling to minimize exposures and possible spread of contamination. This training should disseminate relevant information at an appropriate educational level and should instill a cautious, commonsense attitude toward the handling of radioactive materials. The training should emphasize basic information concerning environmental radiation within a context of relative risk. A multi-media format, including colorful visual aids, demonstration, and discussion, should be used to maximize motivation and retention. A detailed, proposed training program design is presented.

23757 (RHO-SA—165) **What is risk assessment.** Wood, D.E. (Rockwell International Corp., Richland, WA (USA). Energy Systems Group). Feb 1980. Contract AC06-77RL01030. 14p. (CONF-800313—7). NTIS, PC A02/MF A01.

From Waste management conference; Tucson, AZ, USA (10 Mar 1980).

Risk assessment has become a popular, controversial, and sometimes misunderstood subject in the nuclear field. Part of the difficulty is the use of different meanings by different investigators, as well as variations in the depth of analysis considered to be

appropriate. This paper discusses the various meanings, suggests a specific meaning for decisions involving radiological hazards, considers the phases of such an analysis, and proposes an approach to be used where the methodology is incomplete.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 24483, 24490

23758 (BNL—27663) **International safeguards at the feed and withdrawal area of a gas centrifuge uranium enrichment plant.** Gordon, D.M.; Sanborn, J.B. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 18p. (CONF-791117—27). NTIS, PC A02/MF A01.

From ANS topical conference; Kiawah Island, SC, USA (26 Nov 1979).

This paper discusses the application of International Atomic Energy Agency (IAEA) safeguards at a model gas centrifuge uranium enrichment plant designed for the production of low-enriched uranium; particular emphasis is placed upon the verification by the IAEA of the facility material balance accounting. After reviewing the IAEA safeguards objectives and concerns at such a plant, the paper describes the material accountancy performed by the facility operator, and discusses strategies by which the operator might attempt to divert a portion of the declared nuclear materials. Finally, the paper discusses the verification of the declared material balance, including sampling strategies, attributes and variables measurements, and nondestructive measurements to improve the efficiency of the inspection measures.

23759 (CONF-790707—36) **Implementation of the engineering safeguards program (ESP) into nuclear fuel recycle facilities.** Armento, W.J.; Box, W.D.; Brooksbank, R.E.; Kitts, F.G.; Krichinsky, A.M.; Parrott, J.R. Sr. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 6p. NTIS, PC A02/MF A01.

From 20. annual meeting of the Institute of Nuclear Materials Management; Albuquerque, NM, USA (16 Jul 1979).

The principal objective of ORNL-ESP is to demonstrate process monitoring as it might be accomplished by inspectors of any nuclear fuel recycle facility. Improved instrumentation and computer interfacing, currently being installed, provide the ORNL ^{233}U Pilot Plant with the capability of a dynamic volume balance in the solvent extraction system. Later, an accurate, (almost) instantaneous fissile mass balance will be routinely obtainable in the Pilot Plant. Subsidiary objectives include minimizing MUF/LEMUF, detecting material diversions, and alerting appropriate authorities in control of the facility in case of process anomalies. A continuing program will examine technology which might be utilized for facility design. Ultimately, process monitoring/control integrated with safeguards can convert the ORNL ^{233}U Pilot Plant into a partial safeguards demonstration facility.

FUSION FUELS

PROCESSING

FABRICATION AND TESTING

23760 (UCRL—82530) **Characterization techniques for high quality ICF targets.** Weinstein, B.W.; Hendricks, C.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Mar 1979. Contract W-7405-ENG-48. 11p. (CONF-790912—13). NTIS, PC A02/MF A01.

From 9. European conference on controlled fusion and plasma physics; Oxford, UK (17 Sep 1979).

To avoid the effects of fluid instabilities, stringent requirements must be imposed on the surface quality and wall thickness uniformity of fuel pellets used in Inertial Confinement Fusion compression experiments. A systematic method was developed for specifying the type of defects which must be avoided and for evaluating measurement techniques for their suitability for detecting these defects. A review is given of the techniques currently available and those under development to show the relationship between these capabilities and the current and future requirements for pellet uniformity. The speed of these techniques and the implications for automated production of fuel pellets for a reactor are discussed.

23761 **Exploding-pusher-tamper areal density measurement by neutron activation.** Campbell, E.M.; Ploeger, W.M.; Lee, P.H.; Lane, S.M. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). W-7405-ENG-48. *Appl. Phys. Lett.;* **36**: No. 12, 965-967(15 Jun 1980).

Neutron activation of ^{28}Si nuclei was used to measure the areal density rhoΔR of a silicate-glass tamper of a laser-driven exploding-pusher target. The values found were in good agreement with complex computer codes and an empirically based scaling model. This is the first demonstration of a technique that will be used in diagnosing the compression of high-density inertial confinement fusion targets.

23762 **Fusion target evaluation by buoyancy analysis.** Crawley, R.L.; Steinman, D.A. (KMS Fusion, Inc., 3621 S. State Road, Ann Arbor, Michigan 48104). DE-AC08-78DP40030. *Rev. Sci. Instrum.;* **51**: No. 5, 673-674(May 1980).

Projected inertial confinement fusion reactors will require tens of targets per second. This paper describes a device which can measure the diameter and wall thickness of these targets in a precise, simple and rapid fashion.

23763 **Method and apparatus for producing small hollow spheres.** Hendricks, C.D. (to Dept. of Energy). US Patent 4,163,637. 7 Aug 1979. Filed date 29 Sep 1978. 8p.

PAT-APPL-947,665.

A method and apparatus are described for producing small hollow spheres of glass, metal or plastic, wherein the sphere material is mixed with or contains as part of the composition a blowing agent which decomposes at high temperature ($T \geq 600°C$). As the temperature is quickly raised, the blowing agent decomposes and the resulting gas expands from within, thus forming a hollow sphere of controllable thickness. The thus produced hollow spheres (20 to 10^3 μm) have a variety of application, and are particularly useful in the fabrication of targets for laser implosion such as neutron sources, laser fusion physics studies, and laser initiated fusion power plants.

REPROCESSING

23764 **Removal of tritium and tritium-containing compounds from a gaseous stream.** Collins, M.F.; Michalek, R. (to Engelhard Minerals and Chemicals Corp.). US Patent 4,178,350. 11 Dec 1979. Filed date 27 Aug 1973. 8p.

Tritiated species, e.g., tritium, tritiated water, and/or tritiated hydrocarbons, are removed from gas streams containing these by reacting the same over a precious metal catalyst with sufficient air or oxygen to insure conversion of all tritiated species to tritiated water and, if hydrocarbons are present in the gaseous feedstock, carbon dioxide. The tritiated water and any other moisture that might be present in the reaction effluent are next adsorbed by a desiccant dryer, preferably to a level of less than one part per million. Most desirably, the desiccant dryer effluent is then diluted with non-radioactive water such that the tritiated water is diluted by a factor of at least about 1,000 to 1; the resulting water mixture can be adsorbed from the diluted effluent by a second desiccant dryer to provide a value in the ultimate effluent gas of less than about one-half parts per billion tritiated water.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 23768

23765 (UCRL—83928) **Tritium management in fusion synfuel designs.** Galloway, T.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Apr 1980. Contract W-7405-ENG-48. 12p. (CONF-800427—11). Dep. NTIS, PC A02/MF A01.

From Tritium technology in fission, fusion, and isotopic application; Dayton, OH, USA (29 Apr 1980).

Two blanket types are being studied: a lithium-sodium pool boiler and a lithium-oxide- or lithium-sodium pool boiler and a lithium-oxide- or aluminate-microsphere moving bed. For each, a wide variety of current technology was considered in handling the tritium. Here, we show the pool boiler with the sulfur-iodine thermochemical cycle first developed and now being piloted by the General Atomic Company. The tritium (T_2) will be generated in the lithium-sodium mixture where the concentration is $\sim$ 10 ppM and held constant by a scavenging system consisting mainly of permeators. An intermediate sodium loop carries the blanket heat to the thermochemical cycle, and the T_2 in this loop is held to 1 ppM by a similar scavenging system. With this design, we have maintained blanket inventory at 1 kg of tritium, kept thermochemical cycle losses to 5 Ci/d and environmental loss to 10 Ci/d, and held total plant risk inventory at 7 kg tritium.

23766 (UWFPP—6) **Production of substitute natural gas by a fusion hybrid reactor coupled to a catalyzed coal gasification plant. Final report, 1 May 1979-1 October 1979.** Ribe, F.L. (Washington Univ., Seattle (USA). Dept. of Nuclear Engineering). 25 Oct 1979. Contract EY-76-S-06-2225-046. 337p. Dep. NTIS, PC A15/MF A01.

The present study was made to investigate the feasibility of producing synthetic gaseous fuel by means of fusion and to provide a scoping design for a plant. Unlike the other approaches which use pure-fusion reactors with very high temperature blankets to produce hydrogen, the approach here is to use a fusion-fission hybrid reactor to produce substitute natural gas (SNG) from the low-temperature Exxon catalytic coal gasification process and simultaneously to breed fissile fuel. This has the following advantages: (1) The fuel produced uses a variant of conventional technology and is adapted to existing forms of fuel transport. (2) The use of a hybrid fissile-producing blanket multiplies the fusion neutron energy by a large factor over the pure-fusion case, allowing lower fusion-driver gain and first-wall loading. (3) The simultaneous production of synthetic fuel has a favorable effect on the fissile cost, although the synfuel cost is not greatly affected because of the preponderant SNG plant cost. (4) More nearly conventional coolant temperatures are possible in the blanket than for pure-fusion drivers with hydrogen derived from splitting of water. (5) Both outputs of the fusion-hybrid reactor are in storable form; only a minor portion of the plant revenue is from the sale of electricity.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 23721

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

OTHER INDUSTRIAL USES

REFER ALSO TO CITATION(S) 24331

ISOTOPIC POWER SUPPLIES

DESIGN AND FABRICATION

23767 Recent terrestrial and undersea applications of radioisotope thermoelectric generators. Rosell, F.E. Jr. (Defense Systems Management Coll., Fort Belvoir, VA); Vogt, J.F. pp 61-63 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The design and uses of radioisotope thermoelectric generators at remote locations are discussed. These uses include communications and weather stations in Alaska and Antarctica and for a deep-ocean transponder system for measuring missile impacts in the Atlantic Ocean. (LCL)

HYDROGEN

PRODUCTION

REFER ALSO TO CITATION(S) 23777

THERMOCHEMICAL PROCESSES

23768 Thermochemical cycles for the production of hydrogen. Steinberg, M.; Dang, V.D. US Patent Application 005,264. [nd]. 20p.

Two-step processes for the preparation of hydrogen are described: $CrCl_3(g) \rightarrow CrCl_2(g) + 1/2Cl_2(g)$ and $CrCl_2(s) + HCl(g)$ reversible $CrCl_3(s) + 1/2H_2(g)$; $UCl_4(g) \rightarrow UCl_3(g) + 1/2Cl_2(g)$ and $UCl_3(s) + HCl(g) \rightarrow UCl_4(s) + 1/2H_2(g)$; and $CaSO_4(s) \rightarrow CaO(s) + SO_2(g) + 1/2O_2(g)$ and $CaO(s) + SO_2(g) + H_2O(l) \rightarrow CaSO_4(s) + H_2(g)$. The high temperature available from solar collectors, high temperature gas reactors or fusion reactors is utilized in the first step in which the reaction is endothermic. The efficiency is at least 60% and with process heat recovery, the efficiency may be increased up to 74.4%. An apparatus fr carrying out the process in conjunction with a fusion reactor, is described.

23769 Thermochemical cyclic system for splitting water and/or carbon dioxide by means of cerium compounds and reactions useful therein. Bamberger, C.E.; Robinson, P.R. US Patent Application 050,379. [nd]. 21p.

A thermochemical cyclic process for producing hydrogen from water comprises reacting ceric oxide with monobasic or dibasic alkali metal phosphate to yield a solid reaction product, oxygen and water. The solid reaction product, alkali metal carbonate or bicarbonate, and water, are reacted to yield hydrogen, ceric oxide, carbon dioxide and trialkali metal phosphate. Ceric oxide is recycled. Trialkali metal phosphate, carbon dioxide and water are reacted to yield monobasic or dibasic alkali metal phosphate and alkali metal bicarbonate, which are recycled. The cyclic process can be modified for producing carbon monoxide from carbon dioxide by reacting the alkali metal cerous phosphate and alkali metal carbonate or bicarbonate in the absence of water to produce carbon monoxide, ceric oxide, carbon dioxide and trialkali metal phosphate. Carbon monoxide can be converted to hydrogen by the water gas shift reaction.

CHEMISORPTION

REFER ALSO TO CITATION(S) 24394

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 24340, 24341, 24357

PROPERTIES

23770 Multiplicity and stability of nonadiabatic hydrogen-oxygen-nitrogen flames. Heinemann, R.F. Vanderbilt, TN; Vanderbilt Univ. (1979). 109p. University Microfilms Order No. 79-26,607. Thesis (Ph. D.).

The multiple steady states of the rich hydrogen-oxygen-nitrogen flame were studied theoretically and experimentally. Flame multiplicity and stability is shown to be extremely sensitive to the kinetic mechanism used in the mathematical model of a nonadiabatic hydrogen flame stabilized on a flat flame burner. The model using a complex, seven-step mechanism predicts a thermal ignition temperature of 860°K - approximately 300°K higher than the prediction of the model employing a simpler, four-step mechanism. The predictions made by the complex model of the temperature profiles and burn-out conditions of the flame compare much more favorably to experimental measurements than the predictions made by the simple model. The predicted burn-out temperature of the complex flame model is within 30°K of the observed value. The results indicate that observations of flame multiplicity could be quite useful in discriminating between rival kinetic mechanisms. The present study theoretically and experimentally confirms that flat flames are stabilized by losing heat to the burner. We have found flames with high inlet temperatures are quite nonadiabatic, highly stable, and set close to the burner. As the inlet temperature is lowered, the flames lose less heat, are shifted away from the burner, and approach burn-out. This transition to adiabaticity is explained by the decreased reaction rate of the kinetic mechanism at lower temperatures. New qualitative insights into flames were also developed in this work which indicate ignition and burn-out are caused by specific chemical changes in the flame. We show that points of mathematical instability correspond to points of physical and chemical instability. In particular, the hydrogen radical profile can be used to qualitatively predict the transition from one steady state to another.

OTHER SYNTHETIC AND NATURAL FUELS

PREPARATION

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 23773

23771 Method for converting a reaction mixture consisting of hydrocarbon-containing fuel and an oxygen-containing gas into a fuel gas. Kuesebauch, W.; Kostka, H.; Henkel, H.J.; Koch, C.; de Bucs, E.S.; Weber, T. (to Siemens Aktiengesellschaft). US Patent 4,174,954. 20 Nov 1979. Priority date 29 Dec 1975, German, Federal Republic of (F.R. Germany), 10p.

An object of this invention is to increase the conversion attainable with a gas generator, and to increase the load capacity of the reactor charge. This goal is achieved using a gas generator of the type described in US Patent 3,828,736 by embedding the plates into a bed of packing material and by using plates which have higher thermal conductivity than the packing material. A reactor designed in this manner brings about better temperature equalization and a relatively uniform distribution of the flowing reaction mixture over the entire reaction chamber. The highly conductive plates counteract the development of temperature gradients transversely to the

flow direction. The plates themselves as well as the layers of the packing material bed surrounding the plates are heated uniformly; at the same time, the reaction mixture flowing through the reaction chamber is distributed more or less statistically over the packing material pieces.

23772 Partial oxidation process. Paull, P.L.; McGann, R. (to Texaco Inc.). US Patent 4,173,254. 6 Nov 1979. Filed date 29 Nov 1977. 16p.

Sensible heat in the hot effluent gas stream leaving a partial oxidation gas generator for the production of raw synthesis gas, reducing gas, or fuel gas is used at its maximum temperature to produce a continuous stream of superheated steam at a pressure which may exceed the pressure in the gas generator. The by-product superheated steam may be used as a dispersant or carrier of the fuel feed to the generator or as a temperature moderator. Optionally, a portion of the by-product superheated steam may be used as the working fluid in a turbine to produce mechanical work or electrical energy or both. The high steam superheat temperature results in a higher conversion efficiency. A shell and tube heat exchanger in which a stream of steam or cleaned generator gas is continuously bled from inside the tubes to the outside, or the reverse is employed. The bleed stream mixes with the effluent gas stream passing through the heat exchanger. By this means a continuously flowing protective sheath or curtain of comparatively cooler bleedstream is placed between the surfaces of the tubes and headers, if any, in the heat exchanger and the surrounding hot effluent gas stream from the gas generator, which enters the heat exchanger at maximum temperature. The surfaces of the tubes and headers, if any, are thereby protected against corrosive gas attack and deposits of ash, slag, and soot.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 23835, 23836, 23839, 23840, 23841, 23873, 24327

PREPARATION

CHEMICAL SYNTHESIS

23773 (PB—301256) Conversion of coal-based methanol to ethylene and a gaseous fuel. Final report 1 October 1975-30 September 1978. Anthony, R.G. (Texas A and M Univ., College Station (USA). Research Foundation). 1 Dec 1978. 47p. NTIS, PC A03/MF A01.

Development of a catalytic process which converts methanol into ethylene and a gaseous fuel similar to natural gas is reported. The objectives were to invent or discover a catalyst to convert methanol to ethylene, to evaluate the economic feasibility of producing ethylene, and to evaluate the technical and economic feasibility of producing a gaseous fuel from coal-based methanol. An AW-500 type catalyst proved to be the best catalyst for converting methanol into ethylene, 80 to 98 percent of the alcohol being converted into 16 to 60 percent yields of ethylene. Coal-based methanol was converted into a gaseous mixture composed of 50 percent dimethyl ether, 33.3 percent hydrogen and 16.7 percent carbon monoxide by passing the alcohol over alumina and zinc chromite catalysts at 300-500 degrees C. The gas mixture has a heat of combustion and flame temperature approximately equal to that of natural gas. The major cost of producing ethylene or gaseous fuel is the initial cost of synthesis gas produced from coal that is subsequently used to produce methanol.

23774 Catalyst for synthesis of methanol. Baglin, E.G.; Atkinson, G.B.; Nicks, L.J. (to Secretary of the Interior). US Patent 4,181,630. 1 Jan 1980. Filed date 30 Nov 1978. 4p.

A catalyst for synthesis of methanol by the reaction of CO and/or CO_2 and H_2 is prepared from an alloy of copper with a metal from the rare earth or actinide series or group IVB of the periodic table. The alloy is reacted with a gas having sufficient oxidizing power to oxidize the rare earth, actinide or group IVB metals.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 23832, 23835, 23839, 23841

23775 (DOE/CS/4042—T36) Preliminary energy balance and economic of a farm-scale ethanol plant. Jantzen, D.; McKinnon, T. (Solar Energy Research Inst., Golden, CO (USA)). May 1980. Contract EG-77-C-01-4042. 13p. NTIS, PC A02/MF A01.

A small-scale ethanol plant was designed, built, tested, and modified over the past 18 months. The plant currently operating is the second design. A third, and probably final, design will be installed and operating within a few months. The current plant produces approximately 30 gal/hr of 190-proof alcohol on a continuous basis. The new plant will produce 50 gal/hr of 200-proof alcohol. A key feature is the relatively low process heat requirement, which is achieved by extensive use of waste-heat recovery heat exchangers. This is manifested in the low temperatures of the process output streams. Acting on the request of the Office of Alcohol Fuels, US Department of Energy, and at the invitation of the owners, representatives from the Solar Energy Research Institute evaluated the energy balance on the plant. The objective was to help clear up the controversy surrounding the net energy benefit of ethanol production. Although the study was site-specific to the plant and limited in scope, it is indicative of the potential performance of grain-to-ethanol plants in general.

23776 (SERI/TR—352-554) Agricultural sector impacts of making ethanol from grain. Hertzmark, D.; Ray, D.; Parvin, G. (Solar Energy Research Inst., Golden, CO (USA)). Mar 1980. Contract EG-77-C-01-4042. 74p. Dep. NTIS, PC A04/MF A01.

This report presents the results of a model of the effects on the agricultural sector of producing ethanol from corn in the United States between 1979 and 1983. The model is aggregated at the national level, and results are given for all of the major food and feed crops, ethanol joint products, farm income, government payment, and agricultural exports. A stochastic simulation was performed to ascertain the impacts of yield and demand variations on aggregate performance figures. Results indicate minimal impacts on the agricultural sector for production levels of less than 1 billion gallons of ethanol per year. For higher production levels, corn prices will rise sharply, the agricultural sector will be more vulnerable to variations in yields and demands, and joint-product values will fall. Possibilities for ameliorating such effects are discussed, and such concepts as net energy and the biomass refinery are explored.

PREPARATION

REFER ALSO TO CITATION(S) 23415, 23416, 23432, 23433, 23434, 23435, 23436, 23437, 23531

23777 Process for hydrogen recovery from ammonia purge gases. Null, H.R.; Perry, E. (to Monsanto Co.). US Patent 4,180,553. 25 Dec 1979. Filed date 20 Mar 1978. 20p.

Ammonia synthesis processes are disclosed which provide enhanced conversion of hydrogen values to ammonia. In the processes, a purge stream from an ammonia synthesis loop, which purge stream contains ammonia, is contacted at a superatmospheric pressure with the feed side of a separation membrane which exhibits selective permeation of each of hydrogen and ammonia as compared to the permeation of each of methane and argon. A total pressure differential across the membrane is maintained to provide a driving force for the permeation of hydrogen and ammonia through the membrane. A hydrogen-rich permeating gas which contains ammonia is obtained on the permeate exit side of the membrane. The permeating gas is combined with the gas in the ammonia synthesis loop and passed to the ammonia synthesis reaction zone for conversion to ammonia. Ammonia which permeates the membrane can be recovered by the means to remove product ammonia from the gas in the synthesis loop. A non-permeating gas is removed from the feed side of the separation membrane at substantially the same pressure at which the purge stream is contacted with the separation membrane.

23778 Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979). 203p. (CONF-790599—). Tennessee Valley Authority, Office of Agricultural and Chemical Development, Muscle Shoals, AL.

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

The Symposium on Ammonia from Coal was sponsored by TVA and held at Muscle Shoals, AL, May 8 to 10, 1979. The papers deal mainly with various coal gasification processes to provide a raw gas, the purification and shifting of the raw gas to produce synthesis gas and, in less detail, or the synthesis of ammonia and the manufacture of fertilizers. The interest in coal gasification arises from the increased prices of natural gas, naphtha and residual oils and their probably lessened availability in the future. The global market for ammonia for fertilizers is considered with respect to industry capacity, country self-sufficiency, prices, etc. Twenty-three papers from the proceedings have been entered individually into EDB and ERA, and 2 also into EPA; two papers had been entered previously from other sources. (LTN)

23779 TVA-NFDC role in fertilizer development. Davis, C.H. pp 4-6 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

Our fertilizer program is the only area in which TVA has nationwide responsibility, provided in the original TVA Act in 1933. A number of our developments are prominent in the United States and on the world fertilizer scene. We patent our inventions in the United States and issue nonexclusive, royalty-free licenses for their use. We have issued over 600 licenses to about 370 companies

operating 550 plants in 39 states. Many plants in other countries are also using our developments. Our program includes elements of all levels of research, development, demonstration, and education to promote the use of new products and technology. We conduct work in laboratory, bench, and pilot scale. New products are evaluated in laboratory and greenhouse testing. If a new development appears to be promising and industry is not yet ready to take it up, we sometimes build demonstration-scale plants. The demonstration plants give us better scale-up, operating, and economic data and produce enough of a new product to obtain widespread introduction. The feedback of information from the introduction program assists us in working out the problems inherent when new products and processes are first exposed to the real world. Major objectives of our present work include (1) decreasing the use of natural gas or oil in fertilizer production; (2) developing more efficient fertilizers; (3) finding efficient means for processing lower quality US phosphate rock and recovering the uranium from it; (4) decreasing the energy required to produce, transport, and apply fertilizers; and (5) avoiding environmental damage from production and use of fertilizers. We have a pretty well-balanced R and D program with more recent emphasis given to basic nitrogen and phosphate work.

23780 Potential importance of coal as a feedstock for the US fertilizer industry in the future. Wheeler, E.M. (Fertilizer Inst., Washington, DC). pp 8-11 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

The need for alternative sources of ammonia for fertilizer production was recognized several years ago. Several developments since then have complicated the situation: increased US imports of higher priced petroleum, gas and oil discoveries in Mexico, ammonia production in Mexico and the USSR (beyond their own needs), US government policies of raising the price of petroleum and natural gas, low grain prices (so low furnaces can't afford high priced fertilizer), increased foreign demand for US grain, etc. It is apparent that the US will have to make ammonia from coal via coal gasification, but such plants will be so expensive that financial incentives will be needed at first. One favorable factor is that such plants can be located in the corn belt states which have coal supplies and need large quantities of fertilizer. (LTN)

23781 Future availability of feedstocks for ammonia production. Perry, H. (Resources for the Future, Washington, DC). pp 23-31 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

The major economic factors that affect the fuel used for ammonia production are the delivered price of the fuel to the ammonia plant (for both energy and feedstock use), the efficiency with which each fuel can be converted to ammonia, and the capital and operating costs of the ammonia plant, which are different for each type of fuel. The price of delivered fuel is made up of two components: the cost of production and the cost of transporting it to the plant. Both of these factors are site-specific for each plant so that delivered prices of each fuel vary among the different geographic regions. Due to the depletion of domestic reserves of oil and gas and the low probability that new large reserves will be discovered, the real prices of domestic oil and gas are expected to increase rapidly. World oil and gas prices are also expected to rise because of resource depletion. Even if they were not to rise, US policy is directed toward limiting imports of oil and gas in order to reduce balance-of-payments problems, reduce pressure on world oil prices, and to increase security of energy supply so that reliance on domestic resources, such as coal, would be desirable. Present electricity prices are such that the price of electrolytic hydrogen for ammonia production is prohibitive and can be expected to remain less competitive in the future. Domestic coal reserves are very large and real prices should rise much more slowly than the real price of oil and gas. The estimate of fuel prices shows that coal will be about competitive for ammonia production by 1985 and less costly than natural gas by the year 2000. In addition, the use of coal as a feedstock would avoid those difficult national energy problems associated with fuel imports. Thus for both economic and policy reasons, coal will be the preferred fuel for ammonia production in the near future.

23782 Lurgi pressure gasification and its application for ammonia manufacture. Becker, P.D. (Lurgi Kohle und Mineroltechnik GmbH, Frankfurt, West Germany). pp 44-50 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

This paper deals mainly with the production of ammonia from coal. It should be mentioned that Lurgi pressure gasification offers other possibilities for utilizing coal. The most efficient route to convert coal into valuable fuels and products is a coal conversion scheme with a large capacity gasification plant at the front end followed by a series of processes arranged in such a manner that the various components of the gas and the byproducts are utilized in an optimum way, for example, that: H_2 is used for ammonia production, $H_2 + CO$ are used for methanol or oxogas production, CH_4 is then available as pipeline gas or as feed for other processes, tar, oil, naphtha, and phenols are valuable products if recovered in reasonable quantities, and ammonia from the gas liquor can be made available in liquid form. Such a coal utilization complex has the highest thermal efficiency and the specific investment cost can be reduced considerably. An ammonia plant as described in this paper can be an ideal nucleus for the development of modern coal utilization technology.

23783 Winkler coal gasification process and its application in ammonia synthesis plants. Bailey, E.E. (Davy Powergas Inc., Houston, TX); Subramaniam, T.K.; Anwer, J.; Bogner, F. pp 51-62 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

The commercial Winkler gasifiers built so far have been operating at near atmospheric pressure. In the third generation of Winkler generators, gasification will be done under higher pressures. The savings in compression energy obtained by gasifying under elevated pressure are known from the partial oxidation of oil. And most of the coal gasification processes are essentially partial oxidation processes. A fluid bed process has, however, the added advantage that the capacity of a generator increases directly in proportion to the square root of operating pressure. This has a significant effect on the investment cost, especially for larger installations where the number of gasification streams required can, for example, be halved by increasing the operating pressure to 4 bar. Pressurized gasification allows the use of simpler and less expensive, high efficiency venturi-type scrubbers for final dust removal instead of the bulky electrostatic precipitators or Theisen scrubbers used so far in the atmospheric coal gasification plants. Most of the commercial Winkler plants built so far have provided synthesis gas for ammonia production with the gasifiers operating at low pressure (2 psig). This paper contains the description of a commercial Winkler gasification plant used for the production of 300 t/d of ammonia.

23784 Koppers-Totzek coal gasification process and its role in today's coal-based nitrogenous fertilizer production. Beck, B. (Krupp-Koppers GmbH, Essen, West Germany). pp 72-78 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

To be superior to existing solid or fluidized bed technologies, any new process had to provide process features eliminating certain disadvantages. In order to meet the requirements for the application of varying coal types at different locations, besides the general economic and technical targets applicable for any process, for the production of synthesis gas the following process criteria should be fulfilled: acceptance of any kind of coal regardless of its geological, chemical, or physical nature, generation of the maximum yield of useful gas (carbon monoxide and/or hydrogen), no generation of by-products, no outlet of environmental polluting waste products, beneficial thermal efficiency, rugged and simple operation, low maintenance efforts, and high single-train capacities. These requirements are made available by the Koppers-Totzek (KT) process applying the entrained concurrent flow principle. This process features simplicity in design and operation as well as flexibility by acceptance of a wide range of feedstocks available from sources in different countries. Furthermore, it generates the maximum yield of useful gas according to the thermodynamic conditions created by the partial oxidation of coal in the KT gasifier.

23785 Current status of the Texaco coal gasification process. Child, E.T. (Texaco Development Corp., New York, NY). pp 79-85 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

In the development of the Texaco Coal Gasification Process (TCGP), particular emphasis has been placed on having a highly reliable and flexible process that will operate on a wide variety of feedstocks over a broad range of pressures. The TCGP reactor is basically a pressurized, entrained flow gasifier with a low residence time and a slurry feed. It is essentially a noncatalytic process involving the reaction of hydrocarbonaceous materials with oxygen at high temperatures and pressure under conditions of insufficient oxygen for complete combustion. The rapid flame-type reactions that take place produce a gaseous product consisting primarily of hydrogen and carbon monoxide with lesser amounts of water vapor, carbon dioxide, hydrogen sulfide, methane, and nitrogen. It now appears that coal could in the not too distant future become the primary feedstock for new ammonia plants as well as for the retrofitting of existing noncoal based plants. The cost of producing ammonia from coal is very sensitive to: (1) the method of financing

the project, (2) the cost of the delivered coal, and (3) the gasification efficiency and performance of the particular coal under consideration. Due to these factors each case has to be considered individually and, furthermore, several coals must be evaluated before a sound decision can be reached. Except for those situations where coal-based ammonia plants can already be justified, the best compromise, particularly where security of feedstock is an important factor, appears to be the construction of an oil-based plant convertible at a later date to coal or a coal-based plant that can operate with coal, oil, or slurries of coal in oil.

23786 Large oxygen plant economics and reliability. Scharle, W.J. (Air Products and Chemicals, Inc., Allentown, PA). pp 98-108 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

The cost of tonnage gaseous oxygen is generally a significant cost factor to the user, especially since the cryogenic separation of air in itself is an energy intensive process. Also, the reliability of supply of the oxygen gas is usually of critical importance to downstream processes with large investments where outages have significant cost penalties. This paper presents an economic comparison of several alternate process cycles for the production of gaseous oxygen at 99.5% purity and pressures up to 1500 psig, along with considerations relative to equipment reliability and safety. Although a number of process cycles are available, the low pressure cycle with reversing heat exchangers and gaseous oxygen compression is the economic choice. Cryogenic air separation is a mature technology, but increasing energy costs highlight the need to optimize equipment for additional energy savings, and to carefully monitor and control operations. Many years of experience have led to the development of design, quality control, and operating criteria which eliminate potential problems, providing the basis for a high degree of reliability. Data presented here should be useful in integrating an air separation facility into the reliability analysis of a large coal gasification or other processing complex. A fair amount of detail on reversing heat exchangers and gaseous oxygen compressors has been presented in order to demonstrate that these components now have the same high degree of reliability that characterize other cryogenic plant equipment items.

23787 Coal technology for ammonia production. Waitzman, D.A.; Spickard, G.M.; Williamson, P.C.; Nichols, D.E. pp 130-132 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

Each of the coal gasification processes differs in its acceptability of different coals. Different coal characteristics have a tendency to be more favorable for one process or another. Thus, for optimum operation, each coal gasification plant should be custom designed and carefully tailored to the specific coal that is to be used. For any and all of the processes, the specific variables of the coal must be known at the outset in order to predict coal and oxygen consumption rates, ash or slag handling requirements, and process conditions for further gas treatment equipment, such as CO shift, acid gas removal, and gas purification. In the production of ammonia from coal, the main objective is to produce hydrogen. All other conditions being equal, the lower the heat content of the coal, the greater the amount of coal and oxygen that will be required and the greater the amount of CO_2, H_2S, COS, and ash that must be removed. These same requirements apply to high ash fusion temperatures for those processes that melt the coal ash to form a slag. These processes require higher temperatures and, therefore, greater amounts of coal must be burned in the gasifier for a given yield of synthesis gas. High ash fusion temperatures are also a major factor in gasifier refractory selection. Depending on a large number of variables, the coal consumption figures range from 1.3 to over 2.0 tons of coal per ton of ammonia. The exact figure depends on the coal characteristics, the coal gasification process used, and whether or not coal is required to generate steam for turbine compressor drives.

23788 Coal-based ammonia plants: preliminary operating experience of coal gasification at Talcher and Ramagundam fertilizer plants of The Fertilizer Corporation of India. Chaurey, K.H.; Sharma, K.C. (Fertilizer Corp. of India, New Delhi). pp 166-171 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

The Government of India considered setting up large ammonia plants based on coal as feedstock in the late 1960's and approved a 900-t/day ammonia plant each at Talcher in the State of Orissa and Ramagundam in Andhra Pradesh. The plants are similar and have identical process routes. The process adopted for coal gasification is the Koppers-Totzek process. Pulverized coal is transported by means of nitrogen and fed to three gasifiers along with oxygen and steam to produce raw gas containing about 85% $CO + H_2$. The raw gas is cooled and cleaned; thereafter it is compressed to 30 kg/cm^2 pressure for sulfur removal by the Rectisol process where cold methanol at -50°C removes both organic and inorganic sulfur. After sulfur removal, the gas is subjected to water gas shift reaction for conversion of CO to CO_2 and hydrogen. The CO_2 removal is achieved by scrubbing with cold methanol at -53°C in the Rectisol process. Gas free from CO_2 but containing 5 to 6% CO and 0.2% methane goes to liquid nitrogen wash where CO and methane are removed and also required nitrogen is added for achieving the 1:3 ratio of nitrogen to hydrogen for synthesis gas. The synthesis gas is compressed to 230 kg/cm^2 pressure by a centrifugal compressor and sent to an ammonia synthesis reactor where ammonia is formed. Liquid ammonia is separated and stored in a Hortonsphere having a capacity of 1500 t. Ammonia and CO_2 are then processed for production of urea, where the Montecatini total recycle process is employed. The plant is designed to produce 900 t/day of ammonia and 1500 t/day of prilled urea.

23789 Status of the fertilizer industry in India. Mukherjee, S.K. (Tennessee Valley Authority, Muscle Shoals, AL). pp 172-175 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

The current status of the fertilizer industry in India is described and more particularly, the pattern of feedstocks that is in use. The second area is the reasons for our choice of coal as a feedstock back in the late 1960's. The third area is our choice of the entrained gasification process. The future policy in terms of expansion of the industry as related to feedstocks availability and price is discussed. Agricultural production has a decisive influence on India's economy. As such, agriculture continues to be the number one priority in India's economic planning. The strategy is to place emphasis on increasing land productivity; fertilizers play the most dominant role in this strategy. India is the fourth largest country in the world in consumption and in capacity buildup for nitrogen fertilizers. In the year that will end on March 31, 1979, India will be producing 2.25 million tons of nitrogen and will consume 3.6 million tons of nitrogen and a total of 5 million tons of NPK. Urea is the largest tonnage solid fertilizer material; currently it accounts for 87% of total production, namely 4.4 million tons. In another 16 to 18 months, the tonnage of urea will increase to 8.4 million tons. By 1984 to 1985, it will reach 11.5 million tons. This probably would be the largest urea production capacity in the world.

23790 Operating experience on a 1,000-ton/day ammonia plant at Modderfontein. Engelbrecht, A.D.; Partridge, L.J. (AECI Ltd., Johannesburg, South Africa). pp 176-183 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

The major process problems have been described. In addition many minor process difficulties and some major mechanical and instrument problems had to be overcome. The basic process units had been proven elsewhere before being selected for the Modderfontein plant, although at lower capacities and in different process routes. The plant was thus to some extent a prototype. The question may be asked why so many unforeseen problems arose. It will be clear from the discussion of process problems and their resolution that the unique and poorly characterized nature of South African coal must feature very high on the list of causes. The unusual properties of the coal led, directly or indirectly, to the lower coal efficiency, the refractory lining loss, and excessive fly ash generation. It is highly probable that the unexpectedly large NO concentrations in the raw gas were caused by the nature of the coal and the high gasifier operating temperatures necessitated by the poor coal reactivity. It is also fairly certain that trial gasification of the original feedstock in a full-scale gasification plant would have pointed out most of these problems at the design stage. The latter is probably one of the most important lessons to be learned from our experiences. On the positive side it must be said that, notwithstanding the difficulties, the process was basically sound and the plant capable of producing design output of ammonia. The highest daily production achieved so far was 1060 metric tons. The plant operated in 1978 with an on-stream time of 81%.

23791 Future ammonia business: market and economic considerations. Philpot, J.A.; Leonard, J.P. (Chem Systems Inc., Houston, TX). pp 194-197 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

It is the developed, high-energy-cost areas which generally show coal-based ammonia economics in the most favorable light. However, overcapacity, depressed pricing, and availability of cheap imports from gas-rich countries will prevent the construction of ammonia capacity based upon any feedstock in countries such as the United States. We attempt to paint an overall picture of the worldwide ammonia business through the 1980's, showing trends in demand, supply, trade, and costs. Our objective is to indicate likely

US pricing levels. It is these market prices, rather than the alternative costs of ammonia from new gas-based US plants, which will determine the economic viability of coal-based ammonia in the US. The world ammonia business is currently going through a major transition. The balance of feedstock and fuel costs, of operating and capital costs, and of transportation costs has altered to favor producers with access to cheap natural gas. National and international political factors are becoming increasingly important in energy and fertilizer markets and in plant location decisions. The net result has been to create a global overcapacity, which will continue to increase and reach a peak during the early 1980's, and remain at high levels to the mid-1980's. This rapid and major shift in ammonia demand and production away from the developed countries is being accompanied by an increasing concentration of world capacity into the hands of government controlled organizations. This rapid concentration of capacity, and in particular, of export oriented capacity, in the hands of state controlled organizations with political pricing flexibility on feedstocks and products, will have a profound impact upon the pattern of world ammonia trade and pricing while global surpluses persist.

23792 TVA project for production of ammonia from coal. Burnett, J.A. Jr. pp 198-202 of Ammonia from coal. Muscle Shoals, AL; Tennessee Valley Authority (1979).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

The TVA Ammonia from Coal Project consists of retrofitting an 8-ton-per-hour coal gasification and gas purification facility onto the front end of an existing small, modern natural gas-steam reforming ammonia plant located at the National Fertilizer Development Center. The main objective is to provide technical and economic information to the US fertilizer industry for the substitution of coal for natural gas as a feedstock for producing ammonia. The demonstration facility should provide information to serve as a basis for retrofitting existing plants. The coal gasification unit will be based on the Texaco partial oxidation process. The engineering, procurement, and erection of the coal gasification and gas purification facility will be performed by Brown and Root Development, Inc. The air separation plant required to provide high purity oxygen and nitrogen for the process will be handled similarly by Air Products and Chemicals, Inc. The engineering, procurement, and construction of the coal handling and preparation area, interconnections to the existing ammonia plant, slag disposal, and services and utilities required for the complex will be performed by TVA.

SOLID WASTE FUELS

23793 (PB—300690) **Grain-dust pelleting costs and capital requirements for stationary and portable plants.** Schnake, L.D. (Economics, Statistics, and Cooperatives Service, Washington, DC (USA). National Economics Div.). Sep 1979. 35p. NTIS, PC A03/MF A01.

Grain handlers can reduce the hazards associated with grain dust by pelleting the dust. Investment and operating costs are estimated for a portable plant and three sizes of independent stationary and add-on stationary plants (built adjacent to a grain-handling facility) at inland and port locations. Operating costs for the portable plant range from $15.17 to $55.57 per ton, depending on the level of production. Operating costs for the stationary plants range from $12 to $72 per ton, depending on the daily operating time, plant size, type (independe nt or add-on), and location (inland or port).

HYDRO ENERGY

ENVIRONMENTAL ASPECTS

23794 (PB—299691) **Pumped storage development and its environmental effects. Final report Dec 1971-May 1974.** Karadi, G.M. (Wisconsin Univ., Milwaukee (USA). Coll. of Engineering and Applied Science). May 1974. 325p. NTIS, PC A14/MF A01.

The report covers and evaluates the myriad and complex effects of various types of pumped storage schemes on power generation, water resources development, and environmental control.

SOLAR ENERGY

23795 Overview of DOE's solar energy programs. Marvin, H.H. (Dept. of Energy, Washington, DC). pp 19-30 of Role of utility companies in solar energy. Chicago, IL; Institute of Gas Technology (1978).

From Conference on the role of utility companies in solar energy; Washington, DC, USA (6 Nov 1977).

The structure and status of the DOE national solar energy program is outlined. Programs in the areas of direct thermal applications, solar thermal power plants, photovoltaics, wind turbines, OTEC, and biomass are briefly described. (WHK)

23796 Solar energy in Europe. Field, A.A. pp 521-526 of Handbook of energy conservation for mechanical systems in buildings. Roose, R.W. (comp.). New York, NY; Van Nostrand Reinhold Company (1978).

Solar energy developments in the United Kingdom, France, Germany, and Scandinavia are reviewed. (MHR)

RESOURCES AND AVAILABILITY

23797 (SOLAR/0010—80/04) **Environmental data for sites in the National Solar Data Network.** (Automation Industries, Inc., Richland, WA (USA). Vitro Engineering Div.). Apr 1980. Contract W-31-109-ENG-38;AC01-79CS30027. 234p. Dep. NTIS, PC A11/MF A01.

The environmental data are presented in the form of tables for each solar site. The solar sites are grouped into 12 zones, each of which consists of several adjacent states. The solar energy sites are in alphabetical sequence within each zone. The tables provide available meteorological data for reporting sites in the NSDN as follows: (1) insolation: the insolation table presents the total, diffuse, direct, maximum, and extra-terrestrial radiation for the solar site. It also shows the ratio of total extra-terrestrial radiation, as a percent. (2) Temperature: the temperature table gives the average, daytime, nighttime, maximum, minimum and inlet-water temperatures for the solar site. Additional tables are presented for some of these NSDN sites, supplying either wind or relative humidity data, or both. (1) Wind: all of the passive and some of the active solar sites are equipped with wind sensors. These provide information for two wind tables. The first furnishes wind speed and direction. The second table correlates wind speed with time (hours for a range of speeds) for each day. (2) Humidity: the humidity table provides relative humidity values for day and night. It also gives values for the maximum and minimum humidity for each day. A technical discussion of the instruments and measurements used to obtain these data tables is given, and a map illustrating the climate zones is provided.

ECONOMICS

REFER ALSO TO CITATION(S) 23850, 23909, 23940, 24182

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 23803, 23832, 23847, 23848, 23849, 24182, 24260

23798 (DOE/ER—0050) **Climate and energy: a comparative assessment of the Satellite Power System (SPS) and alternative energy technologies.** Kellermeyer, D.A. (Argonne National Lab., IL (USA)). Jan 1980. Contract W-31-109-ENG-38. 69p. Dep. NTIS, PC A04/MF A01.

The potential effects of five energy technologies on global, regional, and local climate were assessed. The energy technologies examined were coal combustion, light water nuclear reactors, satellite power systems, terrestrial photovoltaics, and fusion. The assessment focused on waste heat rejection, production of particulate aerosols, and emissions of carbon dioxide. The current state of climate modeling and long-range climate prediction introduces considerable uncertainty into the assessment, but it may be concluded that waste heat will not produce detectable changes in global climate until world energy use increases 100-fold, although minor effects on local weather may occur now; that primary particulate emissions from coal combustion constitute a small percentage of total atmospheric particulates; that carbon dioxide from coal combustion in the US alone accounts for about 30% of the current increase in global atmospheric CO_2, which may, by about 2050, increase world temperature 2 to 3°C, with pronounced effects on world climate; that rocket exhaust from numerous launches during construction of an SPS may affect the upper atmosphere, with uncertain consequences; and that much research in climatology is needed before potential effects can be quantitatively predicted with any confidence. Although climatic impact is an appropriate concern in formulating

long-term energy policy, the level of uncertainty about it suggests that it is not currently useful as a decision criterion. 88 references.

23799 (SERI/TR—434-484) **Analysis of PURPA and solar energy.** Rice, M. (Solar Energy Research Inst., Golden, CO (USA)). Mar 1980. Contract EG-77-C-01-4042. 108p. NTIS, PC A06/MF A01.

The Public Utility Regulatory Policies Act of 1978 (PURPA) is designed to promote energy conservation, the efficient use of utility resources, and equitable rates. PURPA specifically directs the Federal Energy Regulatory Commission (FERC) to encourage small power production from renewable resources (and also cogeneration of electric energy as well as heat) by setting standards under which facilities qualify for interconnection, and guidelines for sales between utilities and independent facilities. The way FERC carries out this mandate may critically affect the development of solar alternatives to electric power production from fossil and nuclear resources. This report comments on proposed FERC regulations and suggests ways to encourage small power production within the PURPA mandate. In addition, some internal strains within PURPA are analyzed that seem to limit the effectiveness with which FERC can encourage independent facilities, and possible modifications to PURPA are suggested. 255 references.

23800 **Legislation.** *Sol. Law Rep.;* **1**: No. 5, 977-1016(Jan 1980).

An index of abstracts of federal and state legislation pertaining to solar energy is provided. (SPH)

23801 **Quest for certified slar energy engineering personnel.** Hummel, M.F. (Scott Community College, Bettendorf, IA). pp 47-49 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

Three certification programs in common practice that have nation-wide coverage are described: the Institute for the certification of Engineering Technicians, the Manufacturing Engineering Certification Institute; and the American Society for Plant Engineers. The need for such certification in the solar energy field is explored and th questions which arise in the inplementation are discussed. (MHR)

SOLAR ENERGY CONVERSION

REFER ALSO TO CITATION(S) 24014

23802 **Pyroelectric apparatus including effectively intrinsic semiconductor for converting radiant energy into electric energy.** Sher, A. US Patent 4,058,729. 15 Nov 1977. Filed date 30 Jul 1976. 14p.

Radiant energy is converted into electric energy by irradiating a capacitor including a layer of an intrinsic or lightly doped semiconductor, having opposite faces on which first and second insulating layers are respectively provided. First and second metallic contacts are respectively provided on the first and second insulating layers. the radiant energy cyclically heats the dielectric to cause cyclic changes in the capacitance and resistance of the capacitor. The capacitor is initially charged to a voltage just below the breakdown voltage of the insulating and semiconductor layers by temporarily connecting it across a dc source to cause a current to flow through a charging resistor to the capacitor. The device can be utilized as a radiant energy detector, as well as a solar energy cell.

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 23966, 24364, 24367, 24393, 24457, 24467, 24477

23803 (BNL—27720) **Environmental, Health, and Safety Considerations.** Stang, L. (Brookhaven National Lab., Upton, NY (USA)). 28 Apr 1980. Contract AC02-76CH00016. 7p. NTIS, PC A02/MF A01.

Environmental, health, and safety considerations in the manufacturing, operation, and disposal of photovoltaic cells are briefly discussed, and the role of BNL as the field center for DOE information in this area is described. (WHK)

23804 (COO—3004-2) **Thin films of InP for photovoltaic energy conversion. Second quarterly technical progress report, September 29, 1979-December 28, 1979.** Manasevit, H.M.; Ruth, R.P.; Moudy, L.A.; Yang, J.J.; Johnson, R.E. (Rockwell International Corp., Anaheim, CA (USA). Electronic Devices Div.). Jan 1980. Contract AC02-79ET23004. 45p. NTIS, PC A03/MF A01.

A research study is being conducted for the purpose of developing a low-cost high-efficiency thin-film InP heterojunction solar cell based on InP films grown by the metalorganic chemical vapor deposition (MO-CVD) process on suitable substrates. Heterostructure devices of CdS/InP (and possibly indium-tin oxide/InP) are to be prepared at Stanford University using the MO-CVD InP films grown at Rockwell. The work of the second quarter of the program is summarized. Growth parameters have been established using new triethylindium, diethylzinc (DEZn), and PH_3 sources for the formation of Zn-doped p-type InP films in the modified MO-CVD reactor system. Appropriately doped films have been prepared and sent to Stanford for use in deposition of CdS layers. An investigation of the properties of grains and grain boundaries in polycrystalline InP films was begun using several polycrystalline film/substrate combinations, including tungsten (W) layers produced by roller coating and screen-printing on polycrystalline alumina, and mechanically abraded surfaces of single-crystal bulk InP:Fe wafers. An investigation was also undertaken into the use of GaP as an alternative intermediate-layer material to GaAs on low-cost substrates for subsequent growth of InP films. Auger electron spectroscopy analysis done on a group of specially prepared Zn-treated films of polycrystalline InP indicated the presence of Zn at surfaces of InP:Zn films grown on Al and/or heat-treated in high concentrations of DEZn at ~ 600°C. However, no Zn was detected in polycrystalline films grown under deposition conditions that would be expected to produce highly doped p-type epitaxial films if single-crystal substrates were used.

23805 (COO—4094-64) **Solar photovoltaic module degradation from electro-migration.** Hornig, C.F.; Wainwright, E.S.; Forman, S.E.; Hsu, M.S.; Themelis, M.P. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 15 Apr 1980. Contract EY-76-C-02-4094. 27p. NTIS, PC A03/MF A01.

This report discusses the effects of outdoor weathering on both encapsulated and unencapsulated solar photovoltaic modules. Degradation modes that result from exposure in a terrestrial environment and which influence long-term module performance are identified. Two modules, stripped of their protective RTV coating, and a third encapsulated module were placed in the Lincoln Laboratory Rooftop Test Bed in the open-circuit mode and monitored for five months. Monthly visual observations and power measurements were made. The encapsulated module showed no evidence of degradation during the five months of this investigation. The unencapsulated modules showed signs of both physical and electrical degradation. Auger analysis of these unencapsulated cells disclosed two potential degradation modes: first, the migration of Sn between positive and negative surfaces on the same cell; and second, the migration of Sn from the cell's negative grid (when this negative grid is adjacent to a cell row at lower potential or the metal module edge). This migrating Sn, combined with the SiOx antireflective film, altered the coating structure and appearance. Both degradation modes depend on the presence of moisture, and will thus reduce module peak power by 8 to 11 percent. The encapsulated module power remained relatively unchanged. The degradation resulting from moisture contacting the Si cells has the potential to eventually render a module inoperative. The prevention of moisture penetration and entrapment will significantly contribute to module longevity.

23806 (DOE/ET/23010—12) **Cuprous oxide photovoltaic cells. Third quarterly technical progress report, October 9, 1979-January 8, 1980.** (Wayne State Univ., Detroit, MI (USA). Dept. of Chemistry). 1980. Contract AC04-79ET23010. 26p. NTIS, PC A03/MF A01.

Previous work on cuprous oxide Schottky barrier photovoltaic cells showed that some potential improvements were limited by chemical degradations at the junction, e.g. in Al/Cu_2O cells, the aluminum reduced the surface of the Cu_2O to metallic Cu. The present project is being devoted to a study of methods to avoid this problem and also to the development of other methods of improving the efficiency of Cu_2O cells. Some results on Auger studies of the oxide heterojunctions, the preparation of doped Cu_2O by introduction of impurities in the starting copper, the exploration of several methods for the study of diffusion length, and some initial attempts on the laser annealing of Cu_2O are reported. (WHK)

23807 (DOE/ET/23040—4) **Amorphous thin films for solar cell application. Final technical report, March 15, 1979-February 29, 1980.** Jonath, A.D.; Anderson, W.W.; Crowley, J.L.; MacMillan, H.F.; Junga, F.A.; Knudsen, J.F.; Monahan, K.M.; Thornton, J.A. (Lockheed Palo Alto Research Labs., CA (USA)). Mar 1980. Contract AC03-79ET23040. 69p. NTIS, PC A04/MF A01.

Magnetron sputtering, a deposition method in which magnetic confinement of a plasma encourages high deposition rates at low working gas partial pressures, is under investigation in this program as a candidate production technology for large-scale manufacture of high-efficiency, thin-film amorphous silicon solar photovoltaic cells. The approach uses two dc magnetron geometries: (1) a low-cost planar magnetron (PM) system for exploratory and detailed examination of deposition parameter space; and (2) a cylindrical magnetron (CM) system, scalable to production sizes, for deposition of homogeneous films over large areas. Detailed descriptions of these two systems are included. During this first-year effort, amorphous silicon films and device structures were sputtered in both PM and CM systems under a wide range of deposition conditions (i.e., T/sub s/, P/sub Ar/, P/sub H_2/) using both doped and undoped sputter targets. Measured electrical and optical film properties indicate that

control over a wide range of conductivity, photoconductivity, conductivity activation energy, and optical and infrared absorption behavior is achievable. Multiple depositions to fabricate simple MIS device structures and simultaneously to deposit monitor samples of individual constituent layers have been successful. Other program highlights are: (1) deposition rates as great as 1500 A/min were achieved in high-power dc magnetron operation at practical substrate-target spacings; (2) p-type and n-type a-Si:H consistently deposited from p- and n-type targets, respectively; (3) demonstrated correlation of argon and hydrogen partial pressure variations with optical, electronic, and structural properties of magnetron-sputtered a-Si:H films; and (4) initial depositions have achieved properties comparable to those in films made by rf sputtering and glow-discharge methods. The status of the work performed during this program and of the work remaining to be performed is given.

23808 (DOE/ET/23045—1) **Chemical vapor deposition of thin-film polycrystalline Si for low-cost solar cells. First quarterly technical progress report, July 23, 1979-November 2, 1979.** Ruth, R.P.; Simpson, W.I.; Moudy, L.A.; Yang, J.J.J. (Rockwell International Corp., Anaheim, CA (USA). Electronic Devices Div.). Nov 1979. Contract AC03-79ET23045. 35p. NTIS, PC A03/MF A01.

A research program is being conducted for the purpose of developing thin-film polycrystalline Si solar cells on low-cost substrate materials, using chemical vapor deposition (DVC) techniques to prepare the films and vapor-growth doping, thermal diffusion, or ion implantation to produce the required p-n junctions. The results of the first quarter of work are summarized. An existing Si CVD reactor system is being used for the investigations, and its design features are discussed. System background doping concentrations and Si film growth-rate uniformity were determined, and general film quality typical of the system and the reactants in use was established - including the properties of Si-on-saphire films prepared during the course of the initial investigations. These results are described in detail. A working curve for growth of boron-doped p-type Si films (using diborane-in-He as the source) has been established for film growth at ~ 1000°C, covering the concentration range 1×10^{16} to 3×10^{19} cm^{-3}. Similar data for lower-temperature growth are also being obtained. Planned activities for the next quarter are outlined.

23809 (DOE/JPL/954331—80/9) **Silicon materials task of the low cost solar array project (Phase III). Effect of impurities and processing on silicon solar cells. Phase III summary and seventeenth quarterly report, Volume 1: characterization methods for impurities in silicon and impurity effects data base.** Hopkins, R.H.; Davis, J.R.; Rohatgi, A.; Campbell, R.B.; Blais, P.D.; Rai-Choudhury, P.; Stapleton, R.E.; Mollenkopf, H.C.; McCormick, J.R. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). Jan 1980. Contract NAS-7-100-954331. 295p. Dep. NTIS, PC A13/MF A01.

The object of Phase III of the program has been to investigate the effects of various processes, metal contaminants and contaminant-process interactions on the performance of terrestrial silicon solar cells. The study encompassed a variety of tasks including: (1) a detailed examination of thermal processing effects, such as HCl and $POCl_3$ gettering on impurity behavior, (2) completion of the data base and modeling for impurities in n-base silicon, (3) extension of the data base on p-type material to include elements likely to be introduced during the production, refining, or crystal growth of silicon, (4) effects on cell performance on anisotropic impurity distributions in large CZ crystals and silicon webs, and (5) a preliminary assessment of the permanence of the impurity effects. Two major topics are treated: methods to measure and evaluate impurity effects in silicon and comprehensive tabulations of data derived during the study. For example, discussions of deep level spectroscopy, detailed dark I-V measurements, recombination lifetime determination, scanned laser photo-response, and conventional solar cell I-V techniques, as well as descriptions of silicon chemical analysis are included. Considerable data are tabulated on the composition, electrical, and solar cell characteristics of impurity-doped silicon.

23810 (DOE/JPL/954331—80/9(Vol.2)) **Silicon materials task of the low cost solar array project (Phase III). Effects of impurities and processing on silicon solar cells. Phase III summary and seventeenth quarterly report, Volume 2: analysis of impurity behavior.** Hopkins, R.H.; Davis, J.R.; Rohatgi, A.; Campbell, R.B.; Blais, P.D.; Rai-Choudhury, P.; Stapleton, R.E.; Mollenkopf, H.C.; McCormick, J.R. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). 23 Jan 1980. Contract NAS-7-100-954331. 221p. Dep. NTIS, PC A10/MF A01.

The object of this phase of the program has been to investigate the effects of various processes, metal contaminants and contaminant-process interactions on the properties of silicon and on the performance of terrestrial silicon solar cells. The study encompassed topics including thermochemical (gettering) treatments, base doping concentration, base doping type (n vs. p), grain boundary-impurity interaction, non-uniformity of impurity distribution, long term effects of impurities, as well as synergic and complexing phenomena. The program approach consists in: (1) the growth of doubly and multiply-doped silicon single crystals containing a baseline boron or phosphorus dopant and specific impurities which produce deep levels in the forbidden band gap; (2) assessment of these crystals by chemical, microstructural, electrical and solar cell tests; (3) correlation of the impurity type and concentration with crystal quality and device performance; and (4) delineation of the role of impurities and processing on subsequent silicon solar cell performance. The overall results reported are based on the assessment of nearly 200 silicon ingots. (WHK)

23811 (DOE/JPL/954853—80/9) **Investigation of proposed process sequence for the array automated assembly task. Phase II. Quarterly technical progress report, March 28, 1980.** Garcia, A.; Bunyan, S.; Wong, B. (Spectrolab, Inc., Sylmar, CA (USA)). Apr 1980. Contract NAS-7-100-954853. 22p. NTIS, PC A02/MF A01.

Evaluation of infrared drying (at approximately 300°C) PX-10 diffusion source in about one minute or less, revealed comparable results to the conventional oven drying at 150°C for 15 minutes. Initially investigation of the fritted-nickel paste front contact indicated high series resistance. Series resistance was reduced upon solder dipping. Further experimentation on junction isolation by laser scribing the front edge of finished, non-AR coated, solar cells continued this period. All scribing was done in the TEM_{00} laser mode. Non-AR coated cell efficiency as high as 10.4% was achieved at a laser output level of 7 watts/cm^2 and a Q-factor of 3000 pulse/inches. This performance was equivalent to non-AR coated control cells processed by back side scribing and breaking. Further evaluation of the titanium-isopropoxide base spray-on AR solution applied with the Advanced Concepts spray system located at Sensor Technology, Inc., revealed no new results. System is still plagued with problems that interfere with the atomization of the source. A new lamination lay-up procedure has been successfully demonstrated using Crane-Glas to prevent gas entrapment and aluminum foil as a vapor barrier.

23812 (DOE/JPL/955077—79) **Evaluation of the technical feasibility and effective cost of various wafer thicknesses for the manufacture of solar cells. Final report, July 15, 1978-July 15, 1979.** (Solarex Corp., Rockville, MD (USA)). 20 Mar 1980. Contract NAS-7-100-955077. 115p. NTIS, PC A06/MF A01.

The principal activities in the performance of this contract effort include practical evaluation of the Yasunaga YQ-100 saw in a production environment. The wafering system is a free-abrasive multiple-loop single wire machine where the number of wafers/cm is determined by the wire pitch. In addition, the effects of wire diameter and abrasive size were studied. Solar cells were manufactured from each saw run to analyze surface damage and effects varying thickness on efficiency. It was determined that surface damage was much reduced compared to fixed abrasive saws, and as little as 5 to 10 micrometers of surface removal from each side of the wafer was sufficient to obtain optimum efficiency for the particular process which was used. Since thin wafers were produced, an analysis of panel manufacture using thin cells was made with special concern for flexibility of the panels and breakage. The saw was found to be much more labor intensive than expected, and wafering system modifications are recommended which can result in effective cost reduction for the manufacture of solar cells.

23813 (DOE/JPL/955089—80/6) **Silicon solar cell process development, fabrication and analysis. Fifth quarterly report, October 1, 1979-December 31, 1979.** Yoo, H.I.; Iles, P.A.; Ho, F.F. (Optical Coating Lab., Inc., City of Industry, CA (USA). Photoelectronics Div.). 1979. Contract NAS-7-100-955089. 76p. Dep. NTIS, PC A05/MF A01.

This program investigates, develops and utilizes technologies appropriate and necessary for improving the efficiency of solar cells made from various unconventional silicon sheet materials. During this reporting period, work has progressed in fabrication and characterization of solar cells from EFG (RH) multi-ribbon, dendritic webs and cast silicon by HEM. Solar cells were fabricated using various process modifications, such as shallow junction formation, BSF, back surface reflector (BSR), surface etching and texturizing, gettering by mechanical damage and diffusion glass and grain boundary passivation. The solar cell parameters measured included open circuit voltage, short circuit current, curve fill factor, and conversion efficiency (all taken under AMO illumination). Additional measurements under AM1 conditions have been included, for direct evaluation and to collect information on the AM1/AM0 conversion factors for the various sheet materials. Also, measurement for typical cells included spectral response and minority carrier diffusion length. The obtained results were compared to the properties of cells made from conventional single crystalline Czochralski silicon with an emphasis on statistical-evaluation. Increased emphasis was given toward modifying the process to yield increased performance.

23814 (DOE/JPL/955342—4) **Development of Megasonic cleaning for silicon wafers. Quarterly report No. 4.** Mayer, A. (RCA Solid State Div., Somerville, NJ (USA); RCA Labs., Princeton, NJ

(USA)). 1 Apr 1980. Contract NAS-7-100-955342. 25p. NTIS, PC A02/MF A01.

The Megasonic system consisting of the cleaning and rinse tank, the air dryer with the belt drive, and the laser defect scanner, has now been completely assembled, debugged, and tested in the laboratory at various power levels and belt speeds. The results indicate that wafer-throughput design targets have been met and exceeded. At the recommended power input of 160 W per transducer about 4500 wafers per hour can be cleaned and at least 2600 wafer per hour can be dried in 3/32-in.-spaced quartz carriers. As experience accumulated, several sources of contamination were identified. These included turbulence in the laminar-flow air stream, causing unfiltered room air to be inducted into the working area; the temporary aluminum supports for the quartz carriers; wash water contaminated with colloid, leading to slow and inadequate rinse rate; and leaks in the seal between the laminar-flow station and the belt drive. The laser scanner was found to be an excellent diagnostic tool: the pattern of scattering centers displayed on the storage 'scope is almost always indicative of the cause of the problem, be it dust, poor water, or surface defects on the wafer. The solar-cell evaluation test carried out with 22 Megasonically cleaned and 18 system-Z-cleaned solar cells has been completed. It confirms that the Megasonically cleaned cells have higher average efficiency. However, about 17% of the Z-cleaned cells are considerably poorer than the rest; if these are not included, the distribution of the remaining 83% is statistically indistinguishable from that of the Megasonically cleaned ones. It is tentatively concluded that Megasonic cleaning produces a more uniform product with fewer really poor cells, but not cells with an efficiency greater than the maximum attained by Z-cleaned cells.

23815 (DOE/JPL/955533—79/1) **Development of a polysilicon process based on chemical vapor deposition (Phase 1). First quarterly progress report, 6 October-31 December 1979.** McCormick, J.R.; Arvidson, A.; Plahutnik, F.; Sawyer, D.; Sharp, K. (Hemlock Semiconductor Corp., MI (USA)). Jan 1980. Contract NAS-7-100-955533. 65p. Dep. NTIS, PC A04/MF A01.

The goal of this program is to demonstrate that a dichlorosilane based reductive chemical vapor deposition (CVD) process is capable of producing, at low cost, high quality polycrystalline silicon. Physical form and purity of this material will be consistent with LSA material requirements for use in the manufacture of high efficiency solar cells. Chemical processes involved in achieving the objective are reviewed with emphasis placed on advantages of this process when compared with existing polycrystalline silicon production technology. Installation of a CVD reactor with associated analytical instrumentation is described. Preliminary reactor data has been favorable demonstrating the anticipated increased deposition rate and conversion efficiency when dichlorosilane decomposition is compared with trichlorosilane decomposition. No serious problems have been encountered which might limit dichlorosilane use as a reactor feed material. Design considerations for a process development unit (PDU) for dichlorosilane synthesis are reviewed. A design which effectively suppresses monochlorosilane during the redistribution of trichlorosilane was decided upon and its implementation is described. The PDU will be used to collect data on optimization of the redistribution process as well as to determine product quality. Based on experimental data collected during the first quarter along with already available data on the redistribution and hydrogenation processes, a preliminary mass balance is established.

23816 (DOE/SERI—8119-3/1) **Sequential purification and crystal growth for the production of low cost silicon substrates. Quarterly technical progress report No. 1, 15 September 1979-31 December 1979.** Liaw, M.; Secco, F.; Ingle, B.; Down, D. (Motorola, Inc., Phoenix, AZ (USA). Semiconductor Group). Feb 1980. Contract EG-77-C-01-4042. 44p. NTIS, PC A03/MF A01.

Over the past several years, Motorola's Materials Technology Laboratory (MTL), has been conducting several projects with goals directed at the production of high quality low cost silicon crystals. One of the projects which is being investigated is the direct purification of MG-Si. A unique characteristic of the approach used by this project is the use of a crystal puller to perform both purification and crystal growth. Sequential steps of purification were taken. By the completion of this series of purification, the purified MG-Si melt will be further purified by impurity redistribution using ingot pulling. The final purified silicon will be in an ingot form of desired dimensions for slicing into silicon sheets. The sequential steps of purification include: (1) leaching of MG-Si charge, (2) phase separation, (3) reactive gas treatment, (4) liquid-liquid extraction (called Slagging), and (5) purification by redistribution of impurities using ingot pulling. Progress on items (1) and (2) is reported. (WHK)

23817 (DSE—4042-T17) **Commercializatzon of thick film solar cells. Quarterly progress report, September 21, 1979-December 31, 1979.** McDonald, G.D.; Goodman, G. (Globe-Union, Inc., Milwaukee, WI (USA)). 1979. Contract EG-77-C-01-4042. 31p. Dep. NTIS, PC A03/MF A01.

Starting materials for the preparation of thick film cadmium sulfide and cadmium telluride solar cells have been comminuted. Initial trial films of cadmium sulfide showed that during the next phase of this work, the printing of films, one of the major problem areas will be to obtain sufficient reflow in the printed films to remove the screen-caused variation in film thickness. The thin areas corresponding to the screen pattern caused pinholes to form in the fired parts.

23818 (DSE—4042-T30) **Advanced photovoltaic concentrator cells. Quarterly technical progress report No. 1, August 28, 1979-November 30, 1979.** Zehr, S.W.; Yang, H.T.; Harris, J.S. Jr. (Solar Energy Research Inst., Golden, CO (USA)). Dec 1979. Contract EG-77-01-4042. 42p. NTIS, PC A03/MF A01.

First quarter activities for a project aimed at demonstrating the technical feasibility of advanced high efficiency concentrator solar converters are described. The goal of the program is to achieve 30% conversion efficiency with a converter operating at 30°C under 500 to 1000 SUN AM2 illumination and 25% conversion efficiency with a converter operating at 150°C under 500 to 1000 SUN AM2 illumination. The approach is to fabricate two cell, non-lattice matched, monolithic stacked converters using optimum pairs of cells having bandgaps in the range of 1.6 to 1.7 eV and 0.95 to 1.1 eV. The high bandgap cells are to be fabricated using MOCVD or LPE to produce the needed AlGaAs layers of optimized composition, thickness and doping to produce high performance, heteroface homojunction devices, The low bandgap cells are to be similarly fabricated from AlGaSb(As) compositions by LPE. These subcells are then to be joined into a monolithic structure by an appropriate thermal bonding technique which will also form the needed transparent intercell ohmic contact (IOC) between the two subcells. The activities this quarter have been largely focused on the development and study of low bandgap cell structures and attempts to develop suitable techniques for the thermal bonding operation.

23819 (PB—301050) **An analysis of the influence of cell parameters and the spectral content of incident light on the performance of Cu2S-CdS solar cells. Technical report.** Rothwarf, A.; Hadley, H.C. Jr. (Delaware Univ., Newark (USA). Inst. of Energy Conversion). Apr 1975. 18p. NTIS, PC A02/MF A01.

Theoretical and experimental results on the spectral response of CU2CdS solar cells are presented. The response depends upon the absorption coefficient, the thickness of the CU2S layer, the electron diffusion length, the surface recombination velocity, grain size, the drift field in Cu2S, interface recombination processes, the field in the CdS space charge region, and the mode of operation of the cell (front wall, back wall and reflection modes). Comparisons of the expected short circuit current for AMI and a tungsten-iodide AMI simulator, for several sets of parameters are given for the four modes of operation of the cell. The current voltage curves obtained for various light sources are compared. The need for adequate short wavelength content in light sources to be used in the testing of Cu2S-CdS cells in demonstrated.

23820 (SAND—80-0926C) **Photovoltaic systems and applications perspective.** Jones, G.J. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 7p. (CONF-800604—14). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

The National Photovoltaic Program is currently in the process of increasing emphasis on full-scale system experiments in the potential user environment, a natural coccurrence in the evolution of system design and development. At this point large amounts of design information are available and need to be brought together in usable form to support this effort. The state of understanding in the system definition area for the major applications is reviewed, and the remaining issues, especially as they impact the field test activities, are indicated.

23821 (SERI/TP—331-541) **Overview of thick-film technology as applied to solar cells.** Firor, K.; Hogan, S. (Solar Energy Research Inst., Golden, CO (USA)). Jan 1980. Contract EG-77-C-01-4042. 8p. Dep. NTIS, PC A02/MF A01.

Thick-film technology was developed by the electronics industry as a means of fabricating components and miniature circuitry. Today, the solar cell industry is looking at screen printing as an alternate to more expensive, high-vacuum techniques in several of the production steps during the manufacture of silicon solar cells. Screen printing is already fairly well established as a means of providing electrical contact to a cell and for the formation of a back surface field. Now under investigation are the possibilities of non-noble metal contacts and protective and antireflective coatings applied to solar cells by the use of screen printing. Most exciting is the work being done in the non-silicon area on the fabrication of the active layers of a solar cell, using thick-film inks made up of II-VI semiconductors.

23822 **Improvement of polycrystalline silicon solar cells with grain-boundary hydrogenation techniques.** Seager, C.H.; Ginley, D.S.; Zook, J.D. (Sandia National Laboratories, Albuquerque, New

Mexico 87185). DE-AC04-76-DP00789. *Appl. Phys. Lett.;* **36**: No. 10, 831-833(15 May 1980).

Electron-beam-induced-current— and dark-current—voltage measurements have been made on p/n photovoltaic cells fabricated from polycrystalline silicon. These data have demonstrated that grain-boundary hydrogenation greatly reduces grain-boundary minority carrier recombination and improves diode current-voltage characteristics.

23823 Reverse current-voltage characteristics of indium tin oxide/silicon solar cells under illumination. Smith, P.; Singh, R.; DuBow, J. (Department of Electrical Engineering, Colorado State University, Fort Collins, Colorado 80523). XS-9-8232-1. *J. Appl. Phys.;* **51**: No. 4, 2164-2166(Apr 1980).

Recently, Rodriquez and co-workers [J. Appl. Phys. 50, 6011 (1979)] reported anomalous photocurrent in reverse-biased tin oxide/silicon solar cells. We have observed no anomalous photocurrent in our indium tin oxide/silicon semiconductor-insulator-semiconductor (SIS) solar cells. In this paper we have offered a possible explanation of why the authors of the above referred paper have observed anomalous photocurrent in tin oxide/silicon solar cells whereas no such effect has been observed in our indium tin oxide/silicon SIS solar cells.

23824 Sputtered indium-tin oxide/cadmium telluride junctions and cadmium telluride surfaces. Courreges, F.G.; Fahrenbruch, A.L.; Bube, R.H. (Department of Materials Science and Engineering, Stanford University, Stanford, California 94305). *J. Appl. Phys.;* **51**: No. 4, 2175-2183(Apr 1980).

The properties of indium-tin oxide (ITO)/CdTe junction solar cells prepared by rf sputtering of ITO on P-doped CdTe single-crystal substrates have been investigated through measurements of the electrical and photovoltaic properties of ITO/CdTe and In/CdTe junctions, and of electron beam induced currents (EBIC) in ITO/CdTe junctions. In addition, surface properties of CdTe related to the sputtering process were investigated as a function of sputter etching and thermal oxidation using the techniques of surface photovoltage and photoluminescence. ITO/CdTe cells prepared by this sputtering method consist of an n^+-ITO/n-CdTe/p-CdTe buried homojunction with about a 1-μm-thick n-type CdTe layer formed by heating of the surface of the CdTe during sputtering. Solar efficiencies up to 8% have been observed with V/sub 0c/=0.82 V and J/sub s/c=14.5 mA/cm^2. The chief degradation mechanism involves a decrease in V/sub 0c/ with a transformation of the buried homojunction structure to an actual ITO/CdTe heterojunction.

23825 Preparation of thin films for solar energy utilization. Mattox, D.M. (Sandia Laboratories, Albuquerque, New Mexico 87185). DE-AC04-76-DP00789. *J. Vac. Sci. Technol.;* **17**: No. 1, 370-373(Jan 1980).

Thin film deposition techniques have made and are making a significant contribution to solar energy utilization. Commercial applications of thin films include photothermal selective absorbers formed by electroplating, chemical conversion, and vacuum processing; solar reflectors formed by vacuum processes; heat reflectors formed by vacuum processes and spray pyrolysis; and antireflection coating formed by vacuum processes and chemical leaching and the metallization of photovoltaic cells. CdS/Cu_2S photovoltaics formed by vacuum processes and spray pyrolysis are also close to commercial utilization. Principal concerns in thin films applications include economics of fabrication and environmental stability of the thin film materials. At the present time, for many applications the best and most economical film deposition technology is not yet defined. One of the major problems with thin film evaluation is the lack of acceptable testing procedures particularly as related to lifetime. Research and development is continuing in the application of sophisticated thin films to photovoltaic conversion and other applications. This paper reviews the status of thin film in solar energy utilization.

23826 Luminescent solar collector. Davis, R.R.; Sill, R.C.; Yerkes, J.W. (to Atlantic Richfield Co.). US Patent 4,175,980. 27 Nov 1979. Filed date 18 Dec 1978. 6p.

A luminescent solar collector comprising at least one luminescent member which has at least one photovoltaic means operably associated therewith is described. The luminescent member is to be essentially oriented toward the sun when in operation, and has an optically transparent member which is spaced from the sun-side to provide space between the luminescent member and the transparent member. The transparent member is essentially coextensive with the luminescent member. 3 claims.

23827 Photovoltaic cell. Loutfy, R.O.; Hsiao, C.K.; Sharp, J.H. (to Xerox Corp.). US Patent 4,175,982. 27 Nov 1979. Filed date 3 Jul 1978. 10p.

A photovoltaic cell having an improved barrier electrode comprising indium or tin is described. The cell utilizes metalfree phthalocyanine dispersed in an electrically insulated binder as the photoactive layer in contact with an ohmic electrode. 25 claims.

23828 Photovoltaic cell comprising metal-free phthalocyanine. Loutfy, R.O.; McIntyre, L.F.; Sharp, J.H. (to Xerox Corp.). US Patent 4,175,981. 27 Nov 1979. Filed date 3 Jul 1978. 12p.

A photovoltaic cell wherein the photoactive layer comprises a thin layer of metal-free phthalocyanine dispersed in a binder is described. The electrical output is greatly in excess of that obtained from prior art organic semiconductor photovoltaic cells of the same surface area. 30 claims.

23829 Solar collector structures containing thin film polysiloxane, and solar cells. Rapp, C.F.; Boling, N.L. (to Owens-Illinois, Inc.). US Patent 4,173,495. 6 Nov 1979. Filed date 3 May 1978. 8p.

Disclosed is a composite collector and concentrator structure comprising a laminate having a self-supporting layer of solid light transmitting material of extended area in one plane in optical contact with a relatively thin layer of silicone resin derived from a trifunctional silane containing at least one species of luminescent material which absorbs solar radiation and emits electromagnetic radiation of a longer wave length. Use with photovoltaic solar cells is also disclosed. 12 claims.

23830 Glass support light energy converter. Johnson, E.L.; Kilby, J.S.; Lathrop, J.W.; McFerren, J.S.; Myers, D.J. US Patent 4,173,494. 6 Nov 1979. Filed date 14 Feb 1977. 10p.

A radiant energy converter is described in which semiconductor particles are distributed in a single level layer orientation in a glass sheet with portions of each particle exposed at both surfaces of the sheet. A metal layer on one surface of the sheet is in ohmic contact with the body of each particle and forms a common electrode. 19 claims.

23831 Amorphous lead dioxide photovoltaic generator. Schmidt, F.J.; Betz, J.F. (to Ametek, Inc.). US Patent 4,173,497. 6 Nov 1979. Filed date 31 Jul 1978. 6p.

A photovoltaic generator, comprised of photovoltaic amorphous lead dioxide with an oxygen to lead ratio in the range of 1.66 to 1.99, and having rectifying and ohmic junctions, is described. Said lead dioxide may be formed by electrodeposition on substrates, such as copper, nickel, stainless steel, carbon, brass, stannic oxide, indium oxide, and gold plated copper or brass, and generally provides an ohmic junction with the substrate. A rectifying photovoltaic junction of the Schottky barrier type is formed by overcoating the lead oxide with one or more of an evaporated, sputtered or ion plated film of copper, aluminum, Inconel, nickel, gold, platinum, palladium, nickel oxide, titanium, titanium oxide, and copper oxide. 10 claims.

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 23775, 23776, 23793, 23873, 24320, 24327, 24615

23832 (ANL/ES—91) Environmental implications of accelerated gasohol production: preliminary assessment. (Argonne National Lab., IL (USA)). Jan 1980. Contract W-31-109-ENG-38. 129p. NTIS, PC A07/MF A01.

This report assesses the environmental impacts of increasing US production of fuel ethanol by 330 million gallons per year in the 1980 to 1981 time frame in order to substitute gasohol for 10% of the unleaded gasoline consumed in the United States. Alternate biomass feedstocks are examined and corn is selected as the most logical feedstock, based on its availability and cost. Three corn conversion processes that could be used to attain the desired 1980 to 1981 production are identified; fermentation plants that use a feedstock of starch and wastes from an adjacent corn refining plants are found to have environmental and economic advantages. No insurmountable environmental problems can be achieved using current technology; the capital and operating costs of this control are estimated. If ethanol production is increased substantially after 1981, the environmentally acceptable use or disposal of stillage, a liquid by-product of fermentation, could become a serious problem.

23833 (BMI—2031(Vol.3)) Carbohydrate crops as a renewable resource for fuels production. Volume III. Juice preservation. Fink, D.J.; Allen, B.R.; Litchfield, J.H.; Lipinsky, E.S. (Battelle Columbus Labs., OH (USA)). 29 Jan 1980. Contract W-7405-ENG-92. 40p. Dep. NTIS, PC A03/MF A01.

The objective of this study was to evaluate a process to preserve sugar crop juices. The process is energy conserving in that concentrated sugar solutions are produced with little evaporation of water. A preliminary investigation was conducted of polysaccharide hydrolysis as a means for preserving mixed sugar solutions obtained from crops such as sweet sorghum. Four subtasks have been addressed during this report period: I. Concentration of Pure Sugar Solutions by Hydrolysis of Purified Starch; II. Concentration of Genuine Sugar Crop Juice by Hydrolysis of Purified Starch; III. Concentration of Pure Sugar Solutions by Hydrolysis of Genuine Biomass Starch; and IV. Concentration of Pure Sugar Solutions by Hydrolysis of Cellulosic Materials. The results obtained from the

experiments conducted in Subtasks I and II included the following: (1) Concentrated sucrose-glucose-fructose solutions (greater than 50 percent) can be prepared from simulated or actual sweet sorghum juice using enzymatic thinning and saccharification of pure starch-sugar solution mixtures. (2) Enzymatic saccharification of corn meal and cracked wheat in simulated sorghum juice was also demonstrated. (3) Concentration of sugar solutions also can be accomplished by saccharification of cellulosic materials. In our experiments, inhibition of the cellobiase component of the cellulase preparation was observed. The hydrolysis studies were directed to the demonstration of the feasibility of one approach to the preparation of concentrated, microbiologically stable sugar syrups starting with sweet sorghum juice. Future work on Subtask V of this program will continue the investigations already underway and will consider other approaches to the stabilization of juices. Subtask VI of this program will consider the process economics of the Subtask I to IV approaches, or combinations of two or more methods, that are considered to be most feasible for juice preservation.

23834 (BSDF—39-2Q-80) **Technical and economic feasibility of membrane technology. Technical progress report, December 17, 1979-March 16, 1980.** Sandre, A. (Beet Sugar Development Foundation, Fort Collins, CO (USA)). 1980. Contract AC03-79CS40213. 17p. NTIS, PC A02/MF A01.

The potential application of reverse osmosis, ultrafiltration, and electrodialysis to the system of solids concentration in beet sugar process streams was investigated. All available membranes potentially applicable to the process will be tested for application and durability under typical pH, heat pressure and recycle conditions. Possible reduction of energy requirements for evaporation by 15 to 20% is expected.

23835 (DOE/ET/20611—12) **Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model). Quarterly technical progress report, Februray 1, 1980-April 30, 1980.** Ahn, Y.K.; Chen, Y.C.; Chen, H.T.; Helm, R.W.; Nelson, E.T.; Shields, K.J. (Gilbert Associates, Inc., Reading, PA (USA); Environmental Energy Engineering, Inc., Morgantown, WV (USA)). 1980. Contract ET-78-C-02-5022. 19p. NTIS, PC A02/MF A01.

The project will result in two distinct products: (1) a biomass allocation model which will serve as a tool for the energy planner. (2) the experimental data is being generated to help compare and contrast the behavior of a large number of biomass material in thermochemical environments. Based on information in the literature, values have been developed for regional biomass costs and availabilities and for fuel costs and demands. This data is now stored in data banks and may be updated as better data become available. Seventeen biomass materials have been run on the small TGA and the results partially analyzed. Ash analysis has been performed on 60 biomass materials. The Effluent Gas Analyzer with its associated gas chromatographs has been made operational and some runs have been carried out. Using a computerized program for developing product costs, parametric studies on all but 1 of the 14 process configurations being considered have been performed. Background economic data for all the configuration have been developed. Models to simulate biomass gasifications in an entrained and fixed bed have been developed using models previously used for coal gasification. Runs have been carried out in the fluidized and fixed bed reactor modes using a variety of biomass materials in atmospheres of steam, O_2 and air. Check aout of the system continues using fabricated manufacturing cost and efficiency data. A users manual has been written.

23836 (LBL—10667) **Catalytic biomass liquefaction.** Ergun, S.; Figueroa, C.; Karatas, C.; Schaleger, L.; Seth, M.; Wrathall, J.; Yaghoubzadeh, N. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1980. Contract W-7405-ENG-48. 10p. (CONF-800234—1). NTIS, PC A02/MF A01.

From 10. thermochemical conversion contractors' meeting; Berkeley, CA, USA (12 Feb 1980).

LBL reported progress on two major fronts at the 9th Quarterly Thermochemical Contractors' Meeting at Rolla, Missouri, in November, 1979. An important new development in the preparation of pumpable, concentrated biomass slurries was announced, and progress in the fabrication of a bench-scale continuous tubular reactor for liquefaction was detailed. This report, which covers the first quarter of FY80 (October through December, 1979) concerns three tasks: (1) Preparation of biomass slurries; (2) Characterization and flow properties of concentrated slurries; (3) Construction of biomass liquefaction process engineering unit (PEU).

23837 (SIU-IVI—110) **Conversion factors fuelwood: oil.** Nylinder, M. (Sveriges Lantbruksuniversitet, Uppsala. Institutionen foer Virkeslaera). 1979. 56p. NTIS, PC A04/MF A01.

The effective heating value of wood or bark fuels is strongly dependent on the moisture content. The heating value per kg dry wood is about the same for all tree species and tree parts. The effective heating value is about 18 to 13 MJ per kg dry wood at a moisture content (green basis) of 30 to 50%. Because of great variations in basic density for different tree species, the effective heat value varies quite a lot when it is expressed per unit volume. The effective heat value varies from 6 to 9 GJ per m^3 solid wood at a moisture content (green basis) of 50 to 30%. The amount of wood at moisture content 40 to 50% which generate the same heating value as one m^3 of oil (3 to 5) with regard to efficiency is as follows: Pine - stemwood: 5.8 to 6.5 m^3 solid per m^3 oil; Pine - residuals: 6.0 to 6.4 m^3 solid per m^3 oil; Spruce - stemwood: 6.0 to 6.5 m^3 solid per m^3 oil; Spruce - residuals: 5.1 to 6.1 m^3 solid per m^3 oil; Birch - stemwood: 4.8 to 5.2 m^3 solid per m^3 oil; Birch - residuals: 4.8 to 5.2 m^3 solid per m^3 oil. The conversion factors by weight will for all species be: 2.4 to 2.6 ton (dry matter) per m^3 oil : 4.1 to 5.3 ton (green matter) per m^3 oil.

23838 (SRO—1015-T1) **Potentialities of forest biomass as sources of energy.** Brown, C.L. (Georgia Univ., Athens (USA). School of Forest Resources). 1978. Contract EG-77-S-09-1015. 13p. Dep. NTIS, PC A02/MF A01.

Some potentialities which now exist for the use of biomass to help meet a significant portion of our total energy requirement are discussed. The following are discussed: agricultural residues and organic wastes, production systems to increase forest biomass yields, economic considerations, conversion technologies, production of electrical energy, genetic improvements and yields, Georgia's productive capacity, ecological amenities, and realization of energy potentials. (MHR)

23839 **Management assessment of energy from biomass and wastes.** Chicago, IL; Institute of Gas Technology (1980). 201p. (CONF-790172—).

From Management assessment of energy from biomass and wastes conference; Orlando, FL, USA (21 Jan 1979).

The business, economic, political, regulatory, and environmental factors that must be considered in assessing the various routes to energy and synfuels from biomass and wastes are discussed. (DC)

23840 **Anaerobic digestion of marine biomass.** Chynoweth, D.P. Chicago, IL; Institute of Gas Technology (1979). 23p. (CONF-7910126—2).

From Biogas and alcohol production conference; Chicago, IL, USA (25 Oct 1979).

The Institute of Gas Technology (IGT) is actively involved in research on conversion of marine biomass, terrestrial biomass, organic wastes, and blends of biomass and wastes to synthetic fuels. Conversion processes under investigation include anaerobic digestion for production of methane, fermentation for production of alcohols and other liquid fuels, and thermochemical gasification for production of methane or medium-Btu gas. This paper discusses IGT's program on conversion of kelp marine biomass to substitute natural gas (SNG) via anaerobic digestion. It discusses advantages of marine biomass over other forms for large-scale energy conversion, reasons for selection of Macrocystis pyrifera as the first species for study, the overall concept of the kelp farm and conversion system, the integrated research program sponsored by the Gas Research Institute (GRI) and the Department of Energy (DOE) for research and development of this concept, the projected schedule for the research program, a summary of IGT's results to date on anaerobic digestion, and future work planned for development and optimization of the anaerobic digestion process.

23841 **Energy from biomass and wastes: 1979 update.** Klass, D.L. Chicago, IL; Institute of Gas Technology (1979). 44p. (CONF-800129—5).

From Energy from biomass and wastes 4 symposium; Lake Buena Vista, FL, USA (21 Jan 1980).

The R and D activities in progress in the United States on the development of biomass and wastes as renewable energy sources have reached the point where all phases of the technology are under active investigation. Highlights of this effort are briefly reviewed from the standpoint of energy impact, funding, carbon dioxide build-up in the atmosphere, and biomass production and its conversion to energy and synthetic fuels. Special attention is given to alcohols because of the current interest in gasohol. Significant accomplishments were reported in 1979, and it is expected that commercial utilization of this information will begin to gather more momentum.

23842 **National Fuel Alcohol and Farm Commodity Production Act of 1979. Hearings before the Committee on Agriculture, Nutrition, and Forestry, United States Senate, Ninety-Sixth Congress, First Sesson on S. 850, July 17 and 19, 1979.** Washington, DC; Committee on Agriculture, Nutrition, and Forestry (1979). 114p. GPO.

Discussions in the hearings before a Senate subcommittee are recorded. The bill presented to the Senate is also recorded. This bill authorizes the Secretary of Agriculture to guarantee loans for the construction and operation of fuel alcohol plants, to provide for a secure supply of feedstocks for the operation of such plants, to amend the Agricultural Act of 1949 with respect to the set-aside program for feed grains, and for other purposes. (DC)

23843 **Green factories.** Calvin, M. (Univ. of California, Berkeley). *Chem. Eng. News (Wash., D.C.);* **56**: 30-36(20 Mar 1978).

The use of green plants as a source of hydrocarbons for fuels is discussed. Euphorbia, guayule, and Hevea, latex producing plants, were investigated as sources of hydrocarbons. (DC)

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

23844 (SERI/TP—623-656) **Biological solar cell.** Seibert, M.; Janzen, A.F. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract EG-77-C-01-4042. 5p. (CONF-800604—16). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

Recent reports have demonstrated the possibility of employing photoactive, biological membrane components in photoelectrochemical cells. Present studies in our laboratories have led to the attachment of a much simpler biological complex, the bacterial photosynthetic reaction center isolated from Rhodopseudomonas sphaeroides, directly onto a SnO_2 semiconductor electrode. Light-induced photovoltages (70mV) and photocurrents (0.5 $\mu A/cm^2$) not attributable to Dember effects have been observed in photoelectrochemical cells employing reaction-center-coated, SnO_2 working electrodes. Such reaction-center electrodes may serve as model systems for future organic photovoltaic devices.

23845 **Photoelectrochemical cell.** Chen, S.; Russak, M.A.; Witzke, H.; Reichman, J.; Deb, S.K. (to Refac Electronics Corp.). US Patent 4,172,925. 30 Oct 1979. Filed date 22 Feb 1978. 18p.

Photoelectrochemical cell structures and methods of fabrication are disclosed which provide for easily manufactured efficient energy conversion devices. The structures incorporate one or more chambers for the electrolyte, and utilize semiconductor photoelectrodes. In the plural chamber structure, the semiconductor may be opaque, and need not necessarily be a thin film. Specific dopants for the semiconductor provide for decreased dark current and increased open circuit voltage. Post deposition treatment is disclosed for the semiconductor to provide an increased shorting current. Increased sputtering wattage is provided to increase the short circuit current available from the cell. An electrolyte composition is described having improved performance at high light intensity. In a multi-chamber embodiment, the electrode placement causes the photoactive site to be at an end of the chamber removed from the irradiation window, thereby permitting the use of non-transparent photoelectrodes. A third embodiment is disclosed including two photoelectrodes, in combination with a properly selected electrolyte, to provide response to two different portions of the spectrum at an increase operating efficiency. A method and apparatus is disclosed for utilizing a photoelectrochemical cell of the type provided in a dual role, both for electrical conversion of impinging radiation and for heat utilization resulting therefrom. Finally, a multi-chamber, multi-electrolyte structure is disclosed providing electrical charge storage after termination of radiation.

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 23798, 23820, 23876

23846 (DOE-ER—0052) **Selection of alternative central-station technologies for the Satellite Power System (SPS) comparative assessment.** Samsa, M.E. (Argonne National Lab., IL (USA)). Apr 1980. Contract W31-109-ENG-38. 19p. NTIS, PC A02/MF A01.

An important effort in the Satellite Power System (SPS) Comparative Assessment is the selection and characterization of alternative technologies to be compared with the SPS concept. This report summarizes the ground rules, criteria, and screening procedure applied in the selection of those alternative technologies. The final set of central-station alternatives selected for comparison with the SPS concept includes: (1) light water reactor with improved fuel utilization, (2) conventional coal combustion with improved environmental controls, (3) open-cycle gas turbine with integral low-Btu gasifier, (4) terrestrial photovoltaic, (5) liquid metal fast breeder reactor, and (6) magnetic-confinement fusion.

23847 (DOE/ER—0053) **Health and safety. Preliminary comparative assessment of the satellite power system (SPS) and other energy alternatives.** Habegger, L.J.; Gasper, J.R.; Brown, C.D. (Argonne National Lab., IL (USA)). Apr 1980. Contract W-31-109-ENG-38. 126p. Dep. NTIS, PC A07/MF A01.

Existing data on the health and safety risks of a satellite power system and four electrical generation systems are analyzed: a combined-cycle coal power system with a low-Btu gasifier and open-cycle gas turbine, a fission power system with fuel reprocessing, a central-station, terrestrial, solar-photovoltaic power system, and a first-generation design for a fusion power system. The systems are compared on the basis of expected deaths and person-days lost per year associated with 1000 MW of average electricity generation and the number of health and safety risks that are identified as potentially significant but unquantifiable. The appendices provide more detailed information on risks, uncertainties, additional research needed, and references for the identified impacts of each system.

23848 (DOE/ER—0054) **Preliminary comparative assessment of land use for the satellite power system (SPS) and alternative electric energy technologies.** Newsom, D.E.; Wolsko, T.D. (Argonne National Lab., IL (USA)). Apr 1980. Contract W-31-109-ENG-38. 26p. Dep. NTIS, PC A03/MF A01.

A preliminary comparative assessment of land use for the satellite power system (SPS), other solar technologies, and alternative electric energy technologies has been conducted. The alternative technologies are coal-gasification/combined-cycle, coal fluidized-bed combustion (FBC), light water reactor (LWR), liquid metal fast breeder reactor (LMFBR), terrestrial photovoltaics (TPV), solar thermal electric (STE), and ocean thermal energy conversion (OTEC). Fusion was not included in this preliminary work but will be a part of the final evaluation based on available research, to identify a suitable assessment methodology, and to identify data deficiencies. The major issues of a land use assessment are the quantity, purpose, duration, location, and costs of the required land use. The phased methodology described treats the first four issues, but not the costs. Several past efforts at comparative or single-technology assessment are reviewed briefly. The current state of knowledge about land use is described for each technology. Conclusions are drawn regarding deficiencies in the data on comparative land use and needs for further research. (WHK)

23849 (DOE/ER—0055) **Comparative assessment of environmental welfare issues associated with the satellite power system (SPS) and alternative technologies.** Levine, E.P.; Senew, M.J.; Cirillo, R.R. (Argonne National Lab., IL (USA)). Apr 1980. Contract W-31-109-ENG-38. 99p. NTIS, PC A05/MF A01.

Environmental deterioration can affect an individual's health, safety, and welfare (examples of welfare effects include reduced crop yield, loss of property, and interference with other activities). This study identifies sources of environmental deterioration and associated welfare effects from two mature electric power generation systems (combustion of coal and light water nuclear reactors) and compares these with those expected from a conceptual satellite power system. Each activity within the energy pathway for each power system is examined to determine the potential welfare effects it imposes on a community. The severities of these effects are compared. On the basis of this comparison and the state of knowledge concerning specific environmental impacts and welfare effects, key environmental issues are identified for subsequent, in-depth analyses.

23850 (DOE/ER—0056) **Comparative analysis of net energy balance for satellite power systems (SPS) and other energy systems.** Cirillo, R.R.; Cho, B.S.; Monarch, M.R.; Levine, E.P. (Argonne National Lab., IL (USA)). Apr 1980. Contract W-31-109-ENG-38. 143p. Dep. NTIS, PC A06/MF A01.

The net energy balance of seven electric energy systems is assessed: two coal-based, one nuclear, two terrestrial solar, and two solar power satellites, with principal emphasis on the latter two systems. Solar energy systems require much less operating energy per unit of electrical output. However, on the basis of the analysis used here, coal and nuclear systems are two to five times more efficient at extracting useful energy from the primary resource base than are the solar energy systems. The payback period for all systems is less than 1.5 years, except for the terrestrial photovoltaic (19.8 yr) and the solar power satellite system (6.4 yr), both of which rely on energy-intensive silicon cells.

23851 (SAN—2192-T1) **Handbook for battery energy storage photovoltaic power systems. Final report.** (Bechtel National, Inc., San Francisco, CA (USA)). Nov 1979. Contract ET-78-C-03-2192. 128p. (SAND—80-7022). NTIS, PC A07/MF A01.

The principal purpose of this handbook is to provide the photovoltaic system designer with a source of interface design considerations, as well as performance, cost and other necessary information on batteries. The handbook is oriented towards systems analysts, engineers and designers involved with the development, design and evaluation of photovoltaic power systems. To this end, this handbook emphasizes the information needed to successfully select and interface the battery with the remainder of the power system. Details of battery design, construction and theory of operation are addressed only as needed to provide the photovoltaic system designer a better understanding of battery characteristics. This handbook contains information on commercially available batteries, as well as battery types presently under development that have potential for future application in photovoltaic power systems. A glossary of terminology and comparative charts which briefly summarize the principal characteristics of commercially available, near-term and advanced storage battery systems are presented. A

general discussion of battery/photovoltaic power system interface design considerations is given. A discussion of characteristics of commercially available batteries suitable for photovoltaic applications and a presentation of projected characteristics for near-term and advanced battery systems are included. (WHK)

23852 (SAND—80-0873C) **Design and performance of an 11 kW Solar Array Simulator.** Smith, D.R.; O'Sullivan, G.A.; O'Sullivan, F.K. (Sandia Labs., Albuquerque, NM (USA); Abacus Controls, Inc., Somerville, NJ (USA)). 1980. Contract EY-76-C-04-0789. 6p. (CONF-800624—2). Dep. NTIS, PC A02/MF A01.

From Power electronics specialists conference; Atlanta, GA, USA (17 Jun 1980).

A Solar Array Simulator combines a high efficiency switching regulator, a high performance series regulator, and a low power analog adjustable I-V generator to duplicate the static and dynamic characteristics of photovoltaic cells operated in series-parallel combinations. Both voltage and current feedback are used to control the switching and series regulators. Stability of the series regulator over a wide range of load time constants is achieved by a compensation technique. Current-voltage and transient response characteristics of the Simulator are presented. The device was also operated into a 10 kW inverter designed for photovoltaic applications.

23853 (SERI/TR—352-298) **Photovoltaic procurement strategies: an assessment of supply issues.** Posner, D.; Costello, D. (Solar Energy Research Inst., Golden, CO (USA)). Feb 1980. Contract EG-77-C-01-4042. 106p. Dep. NTIS, PC A06/MF A01.

This review report presents the results of an analysis of alternative approaches to the design of a federal photovoltaics procurement program. Advantages and disadvantages of large purchases at fixed prices and smaller purchases for testing and demonstrating the technology are presented. The objectives and possible impacts of these purchase programs on the photovoltaic industry are described. The reactions of the industry to alternative purchase programs were assessed using personal interviews with selected companies currently active in photovoltaics. The report begins with a review of the impacts of federal procurements on other innovations, including the electronics industry, and suggests the relation of these procurements to photovoltaics. The methodology for conducting the interviews is presented next. The results of the interviews are summarized into possible scenarios of future developments in the industry and into discussions of key issues in the design of a procurement program. An appendix on the current structure of the photovoltaic industry is provided.

23854 **Therapeutic adornments utilizing solar cells.** Halfon, L. US Patent 4,173,229. 6 Nov 1979. Filed date 15 Sep 1977. 6p.

A therapeutic adornment or jewelry object is described incorporating a solar cell operable to generate a beneficial electrical current flow through the body of a person wearing same. The solar cell is mounted in a housing effective to electrically insulate the cell itself from a person's body while permitting the transmission of sunlight to the cell's active energy collecting surface. The cell has positive and negative electrical output terminals across which a voltage is generated by the energy collected. The adornment is arranged to mount the cell on a person's body with its active surface exposed to the sun and its terminals electrically connected to spaced apart points on the person's body, whereby a flow of electricity is generted through the person's body between these spaced apart body points. The adornment is illustrated in the forms of a braclet and necklace.

23855 **Terrestrial photovoltaic design: a new experience in systems thinking.** Lindmayer, J.; Putney, Z. (Solarex Corp., Rockville, MD). pp 55-57 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

An analytical procedure developed by Solarex for sizing a stand-alone photovoltaic power supply with electric battery storage is briefly described. The available insolation is determined from recorded data, the load is specified, and the trade-offs between array output and storage capacity are calculated. (WHK)

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 23848, 23850, 24458

23856 (SERI/TP—333-429, pp 1-32) **DOE Solar Thermal Power Systems Program.** Braun, G.W. 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

Solar high temperature concentrator systems have broad market potential and adapt well to existing industrial facilities and power plants. Feasibility has been established and systems will be ready for commercialization by the early 1980's. Industrial process heat comprises a major near-term market which requires solar/fossil hybrid systems. Central receiver technology is well developed. The 10 MW pilot plant near Barstow, California is on track, despite its mixed reception outside the program. Follow-up projects establishing the connection between pilot plant and initial utility and industrial retrofit markets are underway. In the distributed receiver area, the nucleus of a trough collector industry has emerged. Five companies are in business, others are considering production, and the market is encouraging, given present levels of production. The 65-foot test module, now under construction at Crosbyton, Texas, represents a major engineering hurdle for hemispherical bowl technology. Parabolic dish technology is developing rapidly after a late start. The first major installation involving dishes will be located at Shenandoah, Georgia. Advanced development efforts have the objectives of (1) expanding and accelerating market penetration by improving materials and component performance; (2) providing storage technology that enhances capacity factor and fuel displacement potential; and (3) providing higher temperature technology for additional IPH applications and, ultimately, for production of transportable fuels by thermochemocal processes. (WHK)

23857 **Optically driven solar engine.** Gurtler, R.W. (to Motorola, Inc.). US Patent 4,173,123. 6 Nov 1979. Filed date 8 Jul 1977. 6p.

A solar engine is described having a plurality of elements which convert solar energy to usable mechanical motion, such as a piston and a thermally expandable fluid in a cylinder. The sun's rays are focused on a movable mirror which is provided to selectively direct the thermal energy to each of the piston and cylinder thermal energy converting elements. The thermal energy causes expansion of the fluid in the selected cylinder, thus moving the piston to provide mechanical motion. The thermodynamic cycle employed can be selected by the proper choice of the movable mirror timing and by the construction of the piston driven elements of the engine. The result is an efficient, flexible solar engine in which intermediate storage of thermal energy from the sun is not necessary. 4 claims.

CENTRAL RECEIVER

REFER ALSO TO CITATION(S) 23962

23858 (SAND—80-8203) **Utility views on solar thermal central receivers.** Fish, M.J. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1980. Contract EY-76-C-04-0789. 67p. NTIS, PC A04/MF A01.

The solar thermal central receiver concept has been the topic of discussion in recent meetings with a number of southwestern US utilities. These discussions focused on identifying technical demonstrations and government incentives necessary for commercializing the technology. The content of these meetings is summarized in this report, and the implications for a commercialization plan are discussed.

DISTRIBUTED COLLECTOR

REFER ALSO TO CITATION(S) 23966

23859 (DOE/JPL—1060-31) **Point-Cocusing Thermal and Electric Applications Project. Annual technical report, fiscal year 1979. Volume I. Executive summary. JPL Publication 79-118, Volume I.** (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Jan 1980. Contract EX-77-A-29-1060. 36p. NTIS, PC A03/MF A01.

This is a summary of the Point-Focusing Thermal and Electric Applications PFTEA Project's Annual Technical Report for FY 1979. More detailed compilation of results for this year may be found in Volume II. Major activities in FY 1979 centered around the definition and implementation of the engineering experiments that form the main thrust of the PFTEA Project. Phase I of the first experiment, the Small Community Solar Thermal Power Experiment, was completed. As a result of the Phase I concept definition studies that included a small central receiver approach, a point-focusing distributed receiver system with central power generation and a point-focusing distributed receiver concept with distributed power generation, Ford Aerospace and Communications Corporation was selected to pursue the last approach in Phase II. The first experiment in the Isolated Application Series was initiated as a result of procurement activities that culminated with the release of an RFP for the Military Module Power Experiment. A 100 kWe power plant based on Hybrid Brayton technology is being developed in conjunction with the US Navy. Planning for the third engineering experiment series, which addresses the industrial market sector, was initiated in FY 1979. In addition to the experiment-related activities, several contracts to industry were let and studies at JPL were conducted to explore the market potential for Point-Focusing Distributed Receiver (PFDR) Systems. System analysis studies were completed that looked at PFDR technology relative to other small power system technology candidates for the utility market sector.

23860 (SERI/TP—641-653) **Reliability and durability study of a thermal receiver utilizing ASI Type 316 stainless steel in contact with molten aluminum.** Webb, J.; Pohlman, S. (Solar Energy Research Inst., Golden, CO (USA)). Mar 1980. Contract EG-77-C-01-4042. 7p. (CONF-800604—17). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

Compatibility of ASI Type 316 stainless steel with molten aluminum was studied to determine probable lifetimes of unprotected steel components exposed to the liquid aluminum used for heat transfer and storage in a solar receiver supplied as a part of a commercial dish/electric solar generator. Steel samples immersed in molten aluminum showed rapid growth of hemispherical pits accompanied by an exponential increase in weight loss with time. A simple geometric model for the pitting process was developed that correlated well with the data collected on weight loss. Using this model, rate constants for the dissolution process were determined at 705, 760, 816, 871, and 927°C and an activation energy of 17.5 kcal/mole was calculated. An expression for the rate constant was developed enabling use of the pitting model to predict failure time envelopes for the steel receiver components at a given temperature. Maximum lifetimes of the steam coil and wall were predicted to be 94 and 172 hr at 705°C, respectively. Mean predicted lifetimes and lifetimes predicted at higher temperatures were shorter. The model accurately predicted actual lifetimes of field and laboratory tested components. Since failure of the steam coil could lead to a receiver wall failure and cause uncontrolled and possibly violent release of molten aluminum, a recommendation was made that the receiver be operated only at temperatures well below the melting point of aluminum.

TOTAL ENERGY AND HYBRID SYSTEMS

23861 (SERI/TP—333-429, pp 145-149) **Solar total energy project at the Sandia Laboratories Midtemperature Solar Systems Test Facility (MSSTF).** Otts, J. (Sandia Labs., Albuquerque, NM). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The MSSTS serves as a national engineering evaluation center for solar total energy systems - systems which provide electrical power generation along with thermal energy for heating and cooling. The MSSTF consists of (1) the collector module test facility which evaluates troughs and dishes and (2) the solar total energy test facility which is used for system and subsystem development as well as operation and maintenance experience on a total energy system. The solar total energy test facility is described, test results are presented, and the future plans for the facility are outlined.

OCEAN THERMAL GRADIENT POWER PLANTS

23862 (BNL—27710) **Consequences of natural upwelling in oligotrophic marine ecosystems.** Walsh, J.J. (Brookhaven National Lab., Upton, NY (USA)). Mar 1980. Contract EY-76-C-02-0016. 15p. (CONF-800334—12). NTIS, PC A02/MF A01.

From 2. DOE environmental control symposium; Reston, VA, USA (17 Mar 1980).

One of the major environmental consequences of Ocean Thermal Energy Conversion (OTEC) plans may be the artificial upwelling of nutrients to the surface waters of oligotrophic ecosystems. Within a 10 km² area, OTEC plants of 1000 MWe total capacity could upwell the same amount of nutrients as occurs naturally off Peru each day. The biological response to possible eutrophication by OTEC plants may not be similar to that within coastal upwelling ecosystems, however. Upwelling in offshore oceanic systems does not lead to increased primary production despite high nutrient content of the euphotic zone. Continuous grazing may not allow phytoplankton blooms to develop in oceanic upwelling systems to the proposed OTEC sites. At present this is a hypothesis to be tested before full evaluation of OTEC induced upwelling can be made.

23863 (CONF-790631—(Vol.1), pp 8.9.1-8.9.12) **Dynamic and off-design analysis of OTEC closed cycle power systems.** Westerberg, A.W. (Carnegie-Mellon Univ., Pittsburgh, PA); Yao, S.; Jennings, S.J.; Coleman, W.H. 1979.

From 6. OTEC conference; Washington, DC, USA (19 Jun 1979).

An advanced OTEC closed Rankine cycle was formulated and analyzed via power system analytical simulation programs developed by Westinghouse and Carnegie-Mellon University. Since cycle uniqueness precluded selections based on experience, least cost optimization algorithms involving pattern search techniques were used to verify that anhydrous ammonia is the most suitable working fluid and that the particular configuration selected provided maximum power cycle efficiency. A highly favorable net energy balance was achieved and individual components (evaporator, moisture separator, turbine, generator, exciter, condenser and seawater pumps) with a minimum loss, novel control system possessing the requisite flexibility, stability and availability were developed. A unique power plant configuration was developed in response to contract specifications. Dynamic and off-design conditions (start-up, shutdown, part load, overload, varying seawater temperature, and varying levels of biofouling) were simulated on the OTEC power plant and were extensively analyzed with the aforementioned computer programs to demonstrate system transient response, working fluid inventory transfers, and to determine the unique specifications of the balance of plant. Thus, requirements for heat exchanger hotwell capacities, liquid ammonia pump characteristics, connecting pipe sizes, valve specifications, storage capacities, condenser venting loops, etc. were all analytically determined. Finally, requirements for auxiliary power for start-up, purging, emergencies, shut-down, etc. were determined for this complete power cycle, especially with a view towards it being in a ship type hull.

23864 (CONF-790631—(Vol.2), pp 12.1.1-12.1.3) **Biofouling, corrosion, and materials overview.** Kinelski, E.H. (Dept. of Energy, Washington, DC). 1979.

From 6. OTEC conference; Washington, DC, USA (19 Jun 1979).

The OTEC Biofouling, Corrosion and Materials (BCM) Program has been structured to provide the data on materials and biofouling countermeasures needed to assure low-risk operation on the OTEC-10 Pilot Plant. Enumerated are the low-risk options available if the Pilot Plant were to be designed today. Also presented are the tests under way that will qualify additional options for the Pilot Plant preliminary design which is planned for Fiscal Year 1981. A brief overview of the BCM program and the ways it has met and will meet the needs of the OTEC program are described.

23865 (DOE/ER—0049/1) **Some questions and answers about the Satellite Power System (SPS).** (PRC Energy Analysis Co., McLean, VA (USA)). Jan 1980. Contract AC01-79ER10041. 46p. Dep. NTIS, PC A03/MF A01.

The Office of Energy Research, US DOE is evaluating the concept of obtaining significant amounts of electrical energy from space through the Satellite Power System Project Office (SPS PO) formed for that purpose. The SPS PO prepared and is implementing a Concept Development and Evaluation Program plan. The CDEP runs roughly three years (from July 1977 through July 1980) and consists of four primary elements: (1) Systems Definition, (2) Environmental Assessment, (3) Societal Assessment, and (4) Comparative Assessment. One facet of the Societal Assessment is an investigation of public concerns. To further this investigation, a public outreach experiment was initiated to determine the initial response of three selected interest groups to the SPS, both qualitatively and quantititatively, and to gain some experience for use in future public participation activities. Three groups were contacted and agreed to participate in the experiment. They were: the Citizens Energy Project (CEP), the Forum for the Advancement of Students in Science and Technology (FASST), and the L-5 Society (L-5). They each agreed to condense twenty final SPS reports into approximately four pages each, have them typeset, printed and distributed to 3,000 of their constituents for their review, together with a request that they respond to the parent organization regarding the information presented. All responses were summarized and provided to Planning Research Corporation who then solicited the answers from the SPS PO investigator most directly concerned.The questions and answers are presented and will be distributed by the three groups to the individual respondents. Each of the three groups is also preparing a report to the Project Office detailing their work and results. These, together with other responses and studies will be used to more effectively involve the public in the SPS Participatory Technology Process.

23866 (DOE/ET/21002—1) **Evaluation of APL OTEC 10/20 MWE Pilot Plantship. Final report.** (Norske Veritas, Oslo). Dec 1979. Contract AC02-78ET21002. 120p. Dep. NTIS, PC A06/MF A01.

An independent evaluation of the APL Pilot Plant Concept for an OTEC 10/20 MW/sub e/ Power Plant is presented. The object of this feasibility study has been to verify the structural feasibility of concrete hull and cold water pipe (CWP). This has been done through an evaluation of the following items: design philosophy and criteria, material specifications and testing, environmental conditions and loads, structural analyses and design, constructability and deployment, and inspection and maintenance. The study has been concerned mainly with the use of new techniques; new materials; and new applications of recognized techniques in the project. Details which can be solved easily by recognized methods have not been considered. The study is based on the documentation referenced in appendix A, on DnV's independent investigations and on a meeting with the designers. The APL proposal is found to be a feasible and sound conceptual design, meeting all the basic requirements of an OTEC plant. The application of concrete in the hull and in the CWP seems to offer great advantages, mainly related to durability, inspection and maintenance.

23867 (DOE/ET/29187—T3) **Description of the system planning process at Florida Power Corporation. Task I. Report No. FC-5237-1.** (Franklin Inst. Research Labs., Philadelphia, PA (USA)). Jan 1980. Contract AC02-79ET29187. 143p. Dep. NTIS, PC A07/MF A01.

One of the means of evaluating a new technology is to have it considered by a utility company, run through the system planning, and thus scrutinized by a potential user of the new technology in a manner directly drawn from the user's methods of decision making on new capacity additions. By having Florida Power Corporation (FPC), a company with real potential for the future use of ocean thermal energy conversion (OTEC), exercise its system planning methods to consider this possible source of future generating capacity, a number of highly useful results will be obtained. The overall study of the application of system planning to OTEC is being carried out in four tasks. This report covers task-1 which provides a description of the existing system and the planning process of Florida Power Corporation. (WHK)

23868 (DOE/NOAA/OTEC—29(Summ.)) **Preliminary designs for OTEC Stationkeeping Subsystems (SKSS). Summary report.** (Lockheed Missiles and Space Co., Sunnyvale, CA (USA). Ocean Systems Div.). 15 Feb 1979. Contract EG-77-A-29-1078. 108p. (LMSC-D—677804). NTIS, PC A06/MF A01.

This summary report presents a condensation of the designs as developed from requirements and concept selection to preliminary design. The study consists of the following six tasks: (1) Design requirements: establish design environmental conditions and criteria. Develop methodology to both assess SKSS reliability and performance, and minimize life cycle costs. (2) Conceptual design: develop at least two SKSS conceptual designs for both barge and spar platform (eight in all). Consider commercial plant SKSS, verify feasibility, define problem areas, estimate life cycle cost. Develop deployment, operation and maintenance scenarios. Recommend an SKSS concept for each platform. (3) Preliminary design; prepare preliminary designs for two SKSS concepts selected by NOAA/DOE. Optimize the designs, provide deployment and retrieval procedures, support requirements, evaute reliability and performance. Assess effects of watch circle and water depth variation. (4) Development and testing recommendations: recommend programs required to confirm design assumptions and performance predictions, including material and component development, and soils investigation. Estimate cost and schedule required to perform these programs. (5) Cost-time analysis: develop a detailed cost and schedule for the acquisition, transportation, deployment, inspection, maintenance, spares, replacement and salvage for the SKSS designs. (6) Commercial plant SKSS recommendations: assess applicability of designs to commercial plant SKSS. Recommend development program and at-sea tests as requied with estimate of cost and schedule. (WHK)

23869 (DSE—0034-T1) **Performance improvement for ocean thermal energy conversion systems. Final report.** Glasl, F.G.; Pierre, W.F.; Sephton, H.H. (California Univ., Berkeley (USA). Sea Water Conversion Lab.). Mar 1979. Contract EY-76-S-03-0034-255. 167p. Dep. NTIS, PC A08/MF A01.

Experimental data with rotating helical ribbon inserts tested in an OTEC heat transfer test loop are presented. The objectives were to investigate the heat transfer enhancement achievable with rotating helical inserts mounted in heat transfer tubes, and their effectiveness in preventing biofouling at the inner tube wall surface. The inserts tested were 6 Teflon helix-rotors, and one soft-edge helix-rotor. They were all mounted at their upstream ends in heat transfer tubes and free to rotate due to the liquid flow. For coolant flow rates applicable to OTEC plants (above 1 m/s) the increase of the overall heat transfer coefficient was found to range below 20% for all helix-rotors. The local, brine-side heat transfer coefficient ranged up to ca. 25%. However, further improvements of the soft-edge helix-rotor might result in higher heat transfer enhancement. These helix-rotors were quite effective for biofoulant growth control. Tests conducted with San Francisco Bay water over a 6-week period with Teflon helix-rotors mounted in aluminum and titanium tubes demonstrated that the repetitive sweeping of the helix edge over this tube-side surface effectively prevented the accumulation of marine growth that proliferated in the same tubes in sections without helix-rotors.

23870 **Energy conversion system for deriving useful power from sources of low level heat.** Jahnig, C.E. US Patent 4,170,878. 16 Oct 1979. Filed date 13 Oct 1976. 20p.

An energy conversion system is described for deriving useful power from the thermal gradients in the ocean, or from solar, geothermal, or other sources of low level heat, by using warm water to heat a confined working gas such as air whereby a pressure increase results due to warming the gas, arranging so that the expansion moves a piston or other device to extract power, and then cooling the gas and compressing it back to initial conditions while directly or indirectly contacting it with cooler water to thereby decrease the work needed for recompression. Net useful work results from the difference between the work of expansion at higher temperature and the work of recompression at lower temperature.

SOLAR RADIATION UTILIZATION

23871 **Iowa solar operational results conference.** Des Moines, IA; Iowa Solar Office (1979). 121p. (CONF-7906147—).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

Nineteen papers are included. Separate abstracts were prepared for each.

23872 **Solar hot water preheater kit: problems, economics, performance.** Faucett, K.; Faucett, H. pp 1-2 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

The performance of a solar collector installation for preheating domestic water is briefly discussed. The collector is a Pleiad vacuum-flow 80 sq.ft. kit available with selective black absorbers. The storage is a 110 gallon steel tank. Problems with design and freezing are described. (MHR)

23873 **Iowa solar applications: holding at the do-it-yourself level.** Laitner, S. pp 84 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

A series of 10 case studies of representative solar technologies operating in Iowa is presented. The following are included: a solar heated bank using salt storage, an agricultural waste digestion system producing both fuel and fertilizer, an integrated solar/wood heating system virtually free of utility bills, a solar grain dryer designed by an Iowa legislator, a solar water heating and wood-fuel oil space heating system, an underground home with solar attrium, a solar-heated upholstery shop, a solar-heated school and grain dryer, and a farm that never switched from windpower to electric utilities. (MHR)

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 23946, 23947, 23948

23874 **Passive environmental temperature control system.** Corliss, J.M. II; Stickford, G.H. US Patent Application 021,292. [nd]. 15p.

Passive environmental heating and cooling systems are described, which utilize heat pipes to transmit heat to or from a thermal reservoir. In a solar heating system, a heat pipe is utilized to carry heat from a solar heat absorber plate that receives sunlight, through a thermal insulation barrier, to a heat storage wall, with the outer end of the pipe which is in contact with the solar absorber being lower than the inner end. The inclining of the heat pipe assures that the portion of working fluid, such as Freon, which is in a liquid phase will fall by gravity to the outer end of the pipe, thereby assuring diode action that prevents the reverse transfer of heat from the reservoir to the outside on cool nights. In a cooling system, the outer end of the pipe which connects to a heat dissipator, is higher than the inner end that is coupled to a cold reservoir, to allow heat transfer only out of the reservoir to the heat dissipator, and not in the reverse direction.

23875 (BNL—27662) **Solar assisted heat pump program overview and summary of work at Brookhaven National Laboratory.** Andrews, J.W. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 6p. NTIS, PC A02/MF A01.

Four generic paths for avoiding the high utility power demand for solar-assisted heat pump systems when the sun is not shining and storage is depleted are described. These include the bimodal solar-assisted heat pump (SAHP) system, direct-expansion solar collector/heat pump systems, volume-dominated ground-coupled systems, and area-dominated ground coupled systems. Work at BNL on heat pump development, ground coupling, and low-cost collectors for use with these systems is reviewed. (WHK)

23876 (BNL—27667) **Hybrid photovoltaic/thermal systems with a solar-assisted heat pump.** Kush, E.A. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 7p. NTIS, PC A02/MF A01.

An outline of possibilities for effective use of PV/T collectors with a Solar Assisted Heat Pump is given. A quantitative analysis of the performance and cost of the various configurations as a function of regional climates, using up-to-date results from solar heat pump and PV/T collector studies, will be required for more definitive assessment; and it is recommended that these be undertaken in the PV/T Program. Particular attention should be paid to development of high performance PV/T collectors, matching of heat pump

electrical system to PV array and power conditioning characteristics, and optimization of storage options for cost effectiveness and utility impact.

23877 (BNL—27711) **Electric utilities and residential solar systems.** Bright, R.; Davitian, H. (Brookhaven National Lab., Upton, NY (USA)). Apr 1980. Contract EY-76-C-02-0016. 17p. (CONF-800604—21). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

The long-run incremental cost (LRIC) of providing electricity for solar heating and hot water systems is estimated for three utilities using a utility capacity expansion model and compared to the cost of providing electricity to electric-only systems. All investment, fuel and operating costs are accounted for. Hot water systems and combined heating and hot water systems are analyzed separately. It is found that the LRIC for solar backup is no more than the LRIC of electricity used for purely electric heating and hot water devices and also no more than the incremental cost of normal load growth. For the three utilities studied, there appears to be little basis for rate distinctions between solar devices using electric backup and electric-only heating and hot water devices. Off-peak storage heating and hot water devices have a much lower LRIC than the standard systems; again, there appears to be no basis for distinguishing between solar and electric off-peak devices. Compared to average cost pricing, incremental cost pricing offers considerable benefits to customers using solar and electric heat and hot water, especially if a separate lower rate is adopted for off-peak storage devices; these benefits can amount to several hundred dollars per year. Substantial savings in the use of oil and gas fuels can be achieved if residences using these fuels convert to solar systems, savings not necessarily achievable by a shift, instead, to electric systems.

23878 (CONF-790758—(Vol.II)) **Department of Energy's regional solar updates 1979. Volume two. Invited papers and appendices.** (PRC Energy Analysis Co., McLean, VA (USA); Trinity Univ., San Antonio, TX (USA)). 1979. Contract EG-77-C-01-4042;EX-76-A-29-1020. 312p. Dep. NTIS, PC A14/MF A01.

From DOE regional solar update conference; Dearborn, MI, USA (11 Jul 1979).

Twenty-six invited papers for the regional meetings at Dearborn, Michigan; Orlando, Florida; Philadelphia, Pennsylvania; and Los Angeles, California are included. Separate abstracts were prepared for each paper. (MHR)

23879 (DOE/CS—T0145) **Solar-assisted low energy dwellings.** Esbensen, T.V. (Burt, Hill, Kosar, Rittlemann, and Associates, Butler, PA (USA); Mortensen and Esbensen, Sonderborg (Denmark)). Feb 1980. Contract EY-76-S-05-4908. 112p. Dep. NTIS, PC A06/MF A01.

The Zero Energy House Group was formed as a subproject of the CCMS Solar Energy Pilot Study in 1974 by seven participating countries experimenting with solar-assisted low-energy dwellings for temperate and northern European climatic conditions. A Zero Energy House is one in which solar energy is used to meet the reduced energy needs of buildings incorporating various thermal energy conservation features. This final report of the Zero Energy House Group includes brief descriptions of 13 major low-energy dwellings in the participating CCMS countries. An overall assessment of the state-of-the-art in solar-assisted low-energy dwellings is also included.

23880 (DOE/CS/34154—1) **Suncatcher Monitoring Project. Quarterly technical report 1, October-December 1977.** Maeda, B.T. (Earth Integral of Living Systems, Winters, CA (USA)). 29 Feb 1978. Contract FG04-77CS34154. 27p. NTIS, PC A04/MF A01.

Progress in monitoring the Suncatcher solar home is reviewed. The following are included: equipment purchase and preparations, sensor installation, house comfort monitoring, experiments, and natrual gas and electric use. Some data are given. (MHR)

23881 (DOE/CS/34154—2-3) **Suncatcher Monitoring Project. Quarterly technical reports 2 and 3, January-June 1978.** Maeda, B.T. (Earth Integral of Living Systems, Winters, CA (USA)). 21 Jul 1978. Contract FG04-77CS34154. 20p. NTIS, PC A02/MF A01.

Progress in monitoring the Suncatcher solar home is reviewed. The following are included: equipment purchase and preparations, sensor installation, house comfort monitoring, experiments and intensive monitoring, solar hot water heater tests, infrared radiation tests, and gas and electric use. Data are presented. (MHR)

23882 (EPRI-ER—1239(Vol.4)) **Monitoring the performance of solar heated and cooled buildings. Volume 2. Measuring instruments - selection, calibration and installation. Final report.** Armstrong, P.R. (Altas Corp., Santa Cruz, CA (USA)). Nov 1979. 221p. Dep. NTIS, PC A10/MF A01.

Measurements needed to assess the thermal performance of solar heated or cooled buildings are discussed. A handbook of measuring functions and principles is presented. Transducers most appropriate for SHACOB monitoring are discussed in detail. These include, for temperature: semiconductor sensors, thermistors and thermopiles (a new thermopile sensitivity function is presented); for flow: positive displacement and propeller meters with pulse train outputs and heated sensor probes; and for insolation: thermopile and photovoltaic pyranometers. The measurements of concern in passive buildings: heat flux, temperature-time trajectories and mean radiant temperature; and the measurements generally needed to compute thermal capacitance rates in air systems: pressure and humidity; are also discussed. Calibration, installation and signal interfacing considerations are reviewed. Special techniques for measuring fluid flows and enthalpy rates associated with fluid flows (using Btu meters) are described and some new designs proposed. Also presented are a transducer selection procedure, an analysis of sampling error and error propagation, and a review of grounding and shielding practice.

23883 (EUR—6701) **Feasibility study on a combined summer cooling and winter heating system, based on a combination of solar energy and ground heat pumps.** Fordsmand, M.; Eggers-Lura, A. (European Heatpump Consultors Ltd., Charlottenlund (Denmark); Commission of the European Communities, Brussels (Belgium). Directorate General for Research, Science and Education). 1980. 54p. NTIS, PC Q04/MF A01.

The system is planned for a semi-detached (row) one family house with an area of 103 m^2 on two floors. Three European locations chosen for the study are Copenhagen, Paris, and Marseille. The computer model is described and some results presented. (MHR)

23884 (LA-UR—80-693) **Adaptive control for energy conservation.** Farris, D.R. (Los Alamos Scientific Lab., NM (USA)). Mar 1980. Contract W-7405-ENG-36. 3p. (CONF-800340—2). Dep. NTIS, PC A02/MF A01.

From DOE active solar heating and cooling contractors' review meeting; Lake Tahoe, NV, USA (26 Mar 1980).

The objective of this project is to investigate the use of adaptive control concepts in buildings with solar-assisted heating, ventilating, and air-conditioning (HVAC) systems to maintain occupant comfort conditions while minimizing auxiliary energy use. Accomplishing this objective requires an energy management system capable of making sound tradeoffs. Optimal control theory is used along with a system identification technique to provide an adaptable stratgy. The resulting overall approach is known as adaptive optimal control (AOC).

23885 (LA-UR—80-1014) **Residential solar home resale analysis.** Noll, S.A. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 6p. (CONF-800604—15). Dep. NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

One of the determinants of the market acceptance of solar technologies in the residential housing sector is the value placed upon the solar property at the time of resale. The resale factor is shown to be an important economic parameter when net benefits of the solar design are considered over a typical ownership cycle rather than the life cycle of the system. Although a study of solar resale in Davis, Ca, indicates that those particular homes have been appreciating in value faster than nonsolar market comparables, no study has been made that would confirm this conclusion for markets in other geograhical locations with supporting tests of statistical significance. The data to undertake such an analysis is available through numerous local sources; however, case by case data collection is prohibitively expensive. A recommended alternative approach is to make use of real estate market data firms who compile large data bases and provide multi-variate statistical analysis packages.

23886 (LBL—10034) **Human comfort and auxiliary control considerations in passive solar structures.** Place, W.; Kammerud, R.; Andersson, B.; Curtis, B.; Carroll, W.; Christensen, C.; Hannifan, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract W-7405-ENG-48. 10p. (CONF-800524—3). NTIS, PC A02/MF A01.

From International congress on building energy management; Povoa de Varzim, Portugal (12 May 1980).

Energy consumption and human comfort implications of various passive solar and energy conservation strategies are investigated for single-family, one-story, slab-on-grade residences in Albuquerque, NM and Washington, DC. The building energy analysis computer program BLAST is used to perform annual dynamic heating and cooling load calculations for a building in which the glazing area, glazing location, and thermal mass are varied systematically. The impacts on building performance of forced-flow ventilative cooling and nighttime and weekday thermostat setpoint adjustments are investigated. The results indicate that the annual heating and cooling loads are highly sensitive to glazing area, glazing location, and thermostatic controls. Annual cooling loads are substantially reduced by increased thermal mass in the walls. In contrast, annual heating loads are fairly insensitive to increased thermal mass in the

walls, unless very large areas of south glazing are involved. BLAST calculates the air temperatures (T/sub a/) and mean radiant temperatures (T/sub mr/) in each zone for every hour of the year; a weighted average of T/sub a/ and T/sub mr/ is used to evaluate comfort conditions under various circumstances.

23887 (LBL—10770) **Overview-absorption/Rankine solar cooling program.** Wahlig, M.; Heitz, A.; Boyce, B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 7p. (CONF-800340—7). NTIS, PC A02/MF A01.

From DOE active solar heating and cooling contractors' review meeting; Lake Tahoe, NV, USA (26 Mar 1980).

The tasks being performed in the absorption and Rankine program areas run the gamut from basic work on fluids to development of chillers and chiller components, to field and reliability testing of complete cooling systems. In the absorption program, there are six current and five essentially completed projects. In the Rankine program, there are five current projects directly supported by DOE, and three projects funded through and managed by NASA/MSFC (Manned Space Flight Center, Huntsville, Alabama). The basic features of these projects are discussed. The systems under development in five of these current projects have been selected for field testing in the new SOLERAS program, a joint US-Saudi Arabian enterprise. Some technical highlights of the program are presented.

23888 (LBL—10771) **Development of solar driven absorption air conditioners and heat pumps.** Dao, K.; Wahlig, M.; Wali, E.; Rasson, J.; Molishever, E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 5p. (CONF-800340—6). NTIS, PC A02/MF A01.

From DOE active solar heating and cooling contractors' review meeting; Lake Tahoe, NV, USA (26 Mar 1980).

The objective of this project is the development of absorption refrigeration systems for solar active heating and cooling applications. The approaches being investigated are those using air-cooled condenser-absorbers and those leading to coefficient of performances (COP) that increase continuously with heat source temperature. This is primarily an experimental project, with the emphasis on designing, fabricating and testing absorption chillers in operating regimes that are particularly suited for solar energy applications. The first phase of this project has been concluded and has experimentally demonstrated that the conventional single-effect ammonia-water absorption cycle can be used (with minor modifications) for solar cooling. The second phase of this project explores the commercial potential of the single-effect (SE) NH_3/H_2O absorption air conditioner. (WHK)

23889 (NCEI—0013) **Residential passive solar energy design competition for North Carolina. Final report, November 1, 1978-April 9, 1979.** Neal, C.L. (North Carolina Solar Energy Association, Research Triangle Park (USA)). 1979. 74p. Dep. NTIS, PC A04/MF A01.

A passive solar energy design competition is reported. The competition instruction booklet and calculations sheets are included. The purpose of the competition, judging factors, names of the awards jury, dates of the judging and awards, as well as a much simplified solar evaluations procedure with standard inputs for such factors as design temperatures and prevailing winds are presented. (MHR)

23890 (PB—300890) **Performance of a packaged solar space-heating system used with a mobile home.** Jones, D.E.; Hill, J.E. (National Bureau of Standards, Washington, DC (USA)). Aug 1979. 45p. NTIS, PC A03/MF A01.

As part of a continuing program to develop test methods for solar heating equipment, NBS is now developing a standard test procedure for packaged solar space-heating systems similar to test procedures now used for solar collectors and thermal storage devices, and now under development for packaged solar water-heating systems. As a first step, a mobile home, which was previously tested for thermal performance in an environmental chamber, was equipped with a packaged solar space-heating system using air-heating collectors and pebble-bed storage. The system was fully instrumented and data were collected over the 1977-78 heating season at the NBS site in Gaithersburg, Maryland. The performance of the system was determined and various methods of correlating performance were explored.

23891 (PNL-SA—7820) **Supplementary material on passive solar heating concepts. A compilation of published articles.** (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1979. Contract EY-76-C-06-1830. 102p. Dep. NTIS, PC A06/MF A01.

Portions of document are illegible.

A compilation of published articles and reports dealing with passive solar energy concepts for heating and cooling buildings is presented. The following are included: fundamental of passive systems, applications and technical analysis, graphic tools, and information sources. (MHR)

23892 (SAND—78-8176) **Sulfuric acid and water chemical heat pump/chemical energy storage program. Phase II-A. Final report.** Clark, E.C. (Rocket Research Co., Redmond, WA (USA)). 1979. Contract EY-76-C-04-0789. 132p. (RRC—79-R-627). Dep. NTIS, PC A07/MF A01.

Solar charged chemical heat pump/chemical energy storage (solar/CHP/CES) devices offer the ability to utilize solar energy for heat pumping, space cooling, and extended duration thermal energy storage. A study of solar/CHP/CES system economics, system optimization and component testing, and assessment of the ability to commercialize the system is presented. Results are reported in detail. (WHK)

23893 **Self-contained solar greenhouse.** Whitcomb, C.E. (to Oklahoma Agricultural and Mechanical Colleges). US Patent 4,173,212. 6 Nov 1979. Filed date 17 Oct 1977. 6p.

A solar heated greenhouse is described which is formed with a rectangular floor having parallel sides and ends, and a quonset type roof structure supported above the floor. The roof extends to the floor sides and is formed of an inner and an outer spaced-apart light penetrating member. The space between the two members provides a heat collecting chamber. There are water-filled strata beneath the floor, the heat collecting chamber between the roof members communicating with the strata along each side of the floor. Means for spraying water in the heat collecting chamber between the light penetrating member so that the water is heated by solar energy and runs down the chamber and into the strata beneath the floor, and means for recycling water from the strata into the heat collecting chamber whereby water in the strata is heated during sunlit hours and the heat of the water in the strata penetrates the floor and maintains a warm temperature within the greenhouse at night and during sunless days, are described. 9 claims.

23894 **Solar air systems for space heating.** Christensen, R. (Christensen Building Services, Ames, IA). pp 15-17 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

Experience designing and installing two active, hot air solar space heating systems is reviewed. The first employs 320 csquare feet of vertical, flat plate collector and a 250 cubic foot storage room filled with eutectic salt trays. The second installation for Grinnell Federal Savings and Loan has 400 square feet of vertical, flat plate collector and a 275 cubic foot storage room, again filled with eutectic salt. Both systems use collectors and salt trays manufactured by Solar, Inc., and controls and dampers by Honeywell.

23895 **Using a collector 24 hours a day.** Schoenfelder, J.L. pp 18-21 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1079).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

The solar heating systems for the Johnson County Jail in Iowa City, Iowa is discussed. The jail facility requires high ventilation load; consequently, 70% of the design load is ventilation air preheat. Th system provides this fresh directly through the collector; however, in addition, exhaust air is passed through an air passage directly behind the back plate providing heat exchange through the back plate as a heat recovery system. The structure is buried into the hillside such that only the west and south walls of the lower and middle floors are exposed. The system will also provide domestic water preheating. In the summer or when excess heat is available, a coil in the solar duct work will extract heat and store it in a preheater tank. This stored heat will then go the the water heater or the heat can be redirected to the fresh air intake for solar fresh air preheating at night. (MHR)

23896 **Active solar space heating utilizing phase change storage.** Orens, L.O. pp 24-31 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

The system includes a solar wall in which the south wall of the structure has a collector plate for gathering solar energy. The south facing wall of the structure contains the collector plate so as to receive minimum solar radiation during the summer and maximum radiation during the winter. Hot air is collected in the collector area and transferred with a regular blower through conventional duct work to the heat storage unit which in a residence is normally located in the basement. A conventional forced air system which is powered by electricity delivers the heated air to the building's various rooms as needed. The two major components of the system are the collector plate and heat storage unit.

23897 **Solar adaptation of dome structures.** Smith, W.R. pp 32-34 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

The systems are active hydronic systems, using manufactured Farnam, SolarEquip flat plate collectors with an effective aperture of 3' x 7' which, at best, absorbs 87% of available sunlight. The first system, which has been operational through two winters at 56° latitude (Cherokee, Iowa), utilizes eight collectors pitched at 57° from horizontal and axially rotated 5° before noon. The house is a 49 1/2 foot diameter steel hub and 2' x 6' strut dome structure (1/2 sphere). It encloses 3,400 square feet of living space above a 2,000 square foot 12-sided block basement. It is attached via a 26' long entryway to a 26' diameter dome garage. The water is circulated through the collectors during the day in the heating season. The pump cycles on when the sensor in the leading collector of the array registers 3° higher than the stoage tank, an 11,000 gallon redwood tank 18' in diameter and 6' deep. The top of this tank is located flush with the basement floor and is left open for possible swimming. It stores well water, which when added, comes in at 52°F. Storing the water inside the living envelope recovers storage tank heat loss. Water from the pool then goes to twin Carrier water-to-air heat pumps.

23898 Scattergood School solar heating system. Heins, C. (Scattergood School, West Branch, IA). pp 35-42 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

The solar heating system of the Scattergood School is described. The modification for solar grain drying is discussed. The collector performance, storage efficiency, and space and water heating performance are presented. Problems and lessons learned are included. (MHR)

23899 Passive design tutorial. Hodges, L. (Ames Lab., IA). pp 50-65 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

The five major types of passive heating systems are discussed with particular reference to Iowa. Meteorological information and computational methods are provided to enable a designer to estimate the thermal performance of a passive system in Iowa. (MHR)

23900 Passive solar single family residential project. Wetherell, J.J. pp 66-70 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

The siting, design, and construction of a single family residence is covered. The area developers had made provision for underground electric service to each property as the sole energy source for each house. The first floor house interior is open, with family, living, dining, and kitchen areas so located as to receive light and solar heat through south facing windows, skylights, greenhouse wall and roof glass, and clerestory windows. All glazed areas are double glazed or triple glazed, and each glazed area may be closed with blinds, drapes, or fabric covered panels. The insulation, heating equipment, and operating experience are described. (MHR)

23901 Longfellow solar demonstration project. Watson, A. pp 71-76 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

As originally conceived, the retrofitting of this system to a 25 year old 11,000 sq. ft. building found this building as an Elementary School. Before the Grant was awarded, the School District converted the building to the Administrative Offices for the Superintendent, Board Secretary, Physical Plant Director and a Community Gymnasium. Doe officials thought initially that lack of children would make the site less attractive but were later convinced that being able to devote an entire room as a solar classroom, being able to shuttle all levels of classes in and out of this building without distrubing any other classes was a real asset. The building is presently not air conditioned and has an existing gas-fired hot water boiler with 3 zone pumps serving a one-pipe perimeter fin-tube radiation system. Without a shower room or kitchen there is no appreciable domestic hot water load, consequently the Solar System is stricty a Space Heating System. Projection of performance indicated an annual usage of 75% of heating requirements from the solar System. Due to the low bid it was possible to make continued improvements on the design over the last 12 months, all within budget. Problems, successes, and lessons learned are reviewed. (MHR)

23902 Passive solar home. Schoenfelder, J.L. (Central States Energy Research Corp., Iowa City, IA). pp 77-78 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

A passive heated and cooled single family residence in Iowa City, Iowa is described. This project contains two separate passive heating systems, two passive cooling systems, and a passive domestic water heating system. The passive heating systems are a dynamic water and a thermosyphon floor system. Passive cooling is also accomplished in a thermosyphon floor. A stack effect ventilation accelerates air movement through the house to produce a cooling effect. The passive energy participation is estimated to be 70% of the total building load. (MHR)

23903 Direct gainhome using concrete cored slab. Block, D.A.; Hodges, L. (Ames Lab., Ames, IA). pp 80-83 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

The Hodges Residence is an earth-sheltered passive solar home in Ames, Iowa. It will satisf; about 85 percent of its heating requirements by solar energy and need less than 10 million BTU of auxiliary heat in an average winter. At current energy prices in central Iowa this amount of energy would cost about $40 for natural gas heating or $150 for electric resistance heating. This performance results from an energy-conserving design, solar heating through over 500 square feet of glass on the south side, and over 100 tons of concrete heat storage in the interior. The solar system is estimated to have added only 6 percent to the cost of the house and led to a much more durable and maintenance-free house.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

REFER ALSO TO CITATION(S) 23898, 23955, 23957

23904 (DOE/NASA/CR—161414) **Solar process water heat for the Iris Images Custom Color Photo Lab. Final report.** (Interactive Resources, Inc., Point Richmond, CA (USA)). Mar 1980. Contract EX-76-C-01-2381;EX-76-A-29-1024. 126p. Dep. NTIS, PC A07/MF A01.

This is the final technical report of the solar facility locted at Iris Images Custom Photo Laboratory in Mill Valley, California. It was designed to provide 59 percent of the hot water requirements for developing photographic film and domestic hot water use. The design load is to provide 6 gallons of hot water per minute for 8 hours per working day at 100°F. It has 640 square feet of flat plate collectors and 360 gallons of hot water storage. The auxiliary back up system is a conventional gas-fired water heater. Freeze protection in this mild climate was originally provided by closed-loop circulation of hot water from the storage tank. Later this was changed to a drain-down system due to a freeze when electrical power failed. This system has been relatively successful with little or no scheduled maintenance. The site and building description, subsystem description, as-built drawings, cost breakdown and analysis, performance analysis, lessons learned, and the operation and maintenance manual are included.

23905 (SERI/TP—333-429) **Solar industrial process heat conference proceedings.** (Solar Energy Research Inst., Golden, CO (USA)). 1979. Contract EG-77-C-01-4042. 533p. (CONF-791024—). NTIS, PC A23/MF A01.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

Separate abstracts were prepared for 41 of the 54 papers presented. The remaining thirteen papers were previously included in the data base. (WHK)

23906 (SERI/TP—333-429, pp 33-39) **Review of four DOE-sponsored solar dehydration systems.** Dickinson, W.C. (Lawrence Livermore Lab., CA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The operating experience to date is summarized for four DOE-sponsored solar dehydration systems. These are: a raisin-drying plant in Fresno, CA, a lumber-drying facility in Canton, MS, a soybean-drying plant in Decatur, AL, and an onion-drying plant in Gilroy, CA.

23907 (SERI/TP—333-429, pp 47-54) **Seven DOE intermediate temperature (350°F to 550°F) steam demonstration projects.** Mills, J. (Idaho National Engineering Lab., Idaho Falls). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

This review paper provides a synopsis of the seven Department of Energy (DOE) intermediate temperature (350° to 550°F) steam demonstration projects, the designs of which were completed in June of 1979. These projects were designed by various private contractors to provide a portion of the process steam requirements used in a variety of industrial processes including oil heating, latex production, hectorite processing, oil refining, brewing, chlorine

manufacturing and potato processing. For all but one of these projects, two generic kinds of system configuration have been utilized: (1) pressurized water is circulated through a collector field and then flashed to steam in a low pressure chamber, or (2) an organic heat transfer fluid is circulated in the collector array and then fed to a steam generator where the fluid serves as a heat source to produce steam. The system design of each of these seven projects is outlined in this review and the current status of each project is cataloged. Finally, the objectives of this current series of DOE demonstration projects are discussed, and the potential impact of programs such as these upon the widespread commercialization of solar energy process heat applications within the private industrial sector of the United States is addressed.

23908 (SERI/TP—333-429, pp 61-68) **New DOE-funded projects.** Greyerbiehl, J.M. (Dept. of Energy, Washington, DC). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

During FY 79, two Program Opportunity Notices (PON's) and one Request for Proposals (RFP) were issued by the Department of Energy for the design, construction, and operation of solar systems for industrial applications. As the result of the two PON's six firms were selected to produce industrial systems in the temperature range 212°F to 550°F and sizes ranging from 30,000 ft² to 250,000 ft². Those firms awarded contracts for solar industrial process heat systems (30,000 to 50,000 ft²) in the temperature range 212°F to 550°F were Bates Container, Inc., Columbia Gas System Service, Hilo Coast Processing Co., and Southwest Research Institute. Two contracts were awarded for the production of steam for Solar Enhanced Oil Recovery operations of temperatures to 700°F and sizes approaching 250,000 ft². Responses to the RFP are currently being evaluated for industrial process heat systems below 212°F and 30,000 to 70,000 ft² in size.

23909 (SERI/TP—333-429, pp 69-74) **Solar industrial process steam: an economic analysis.** Allen, D.J.; Gangadharan, A.C.; Gupta, G.D. 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

An analysis using a discounted-cash-flow technique was performed to evaluate the economic viability of the solar industrial process steam system utilizing concentrating distributed collectors which will be installed at Dow Chemical Company's Latex Manufacturing Plant in Dalton, Georgia. The influence of tax incentives, capital structure, depreciation method and period, potential reductions in the cost of such systems, and inflation rates were examined. A particularly important parameter in this analysis was found to be the differential between anticipated inflation and fuel cost escalation rates. Conclusions were drawn as to the circumstances in which such solar steam systems will prove to be economically attractive to process industries.

23910 (SERI/TP—333-429, pp 81-85) **Industrial applications analysis: market characterization and system definition for several industries.** Brown, K.C.; Ketels, P.A.; Stadjuhar, S.A. 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The primary objectives of the FY79 solar industrial process heat market characterization/system analysis program were the following: (1) characterize the industrial process heat market by industry and location to identify key market sectors; (2) select a number of industry categories for in-depth study of technical and economic parameters; and (3) evaluate the feasibility of solar applications within the specific industries. A brief discussion of the results of the analysis for the dairy industry is given. (WHK)

23911 (SERI/TP—333-429, pp 91-95) **Solar-industrial heat for New York State: a case study in regional impact on economic viability.** Cassedy, E.S. (Poltechnic Institute of NY, Brooklyn). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

A study has been conducted to identify the economic potential for solar heat in the New York State processing industries, under the assumption of future escalation of fuel prices. In the course of this study it was necessary to identify the particular industries, their process-heat demands and their (regional) locations. New York State has been divided into two solar-performance regions: Downstate, consisting mainly of the New York City Metropolitan area and Upstate, the remaining rural and industrial areas. The climatology of these two regions is markedly different, with annual average insolation levels and ambient temperatures having a significant impact on solar performance in the low to intermediate range of industrial application temperatures (below 550°F). Of the six most energy-intensive processing industries (nationally), three only are promising for the State. The Primary Metals and Stone, Clay and Glass industries are eliminated from the solar applications, because over 96% of their processes are well above 500°F. The State has virtually no petroleum refining. This leaves only the Food and Kindred Products, Paper and Allied Products and Chemical industries to consider for solar in the State and of these the latter two are located primarily Upstate. Analysis has been carried out on each of these three industries, using the parameters of: heat demand, fuel type, application temperature, process-heat ratio, conventional-fuel system efficiencies and region to determine the state-wide economic potential market for 1985, using scenarios of (oil and natural gas) fuel price escalations and level of government incentives. The regional effect is paramount in these results. Examples of individual manufacturing plants within each of the three industries have been studied, in order to verify some of the generic characteristics used in the analysis. This included site visits to the plants and discussions with company representatives in each case.

23912 (SERI/TP—333-429, pp 97-102) **Economic viability of the solar-assisted industrial heat pump system.** Duncan, R.T.; Van Zuiden, G.J. (Westinghouse Electric Corp., Falls Church, VA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The US Senate is currently considering a bill (S.1760) which should increase the tax credit allowed for solar industrial process heat (IPH) systems from the present 20%, up to 50% of the installed cost of such systems. The thermal performance and economics of solar-assisted industrial heat pump systems are assessed in typical IPH applications, as versus electricity, gas and oil, in three climate regions, under a present economic scenario, and under the scenario implicit in S.1760. TRNSYS Version 9.0 and SOLCOST Version 2.0 were employed to assess the 20-year life cycle economics of systems to identify the installation year(s) by which a system would yield a payback of less than 5 years and a return on investment of 25% or greater. It is concluded that the 30% additional solar IPH tax credit resulting from S.1760 would hasten the date of achieving economic viability by 4 to 5 years in most parts of the United States.

23913 (SERI/TP—333-429, pp 115-120) **Gas Research Institute's solar-augmented applications in industry program.** Fiore, V.B.; Williams, J.H. 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The Gas Research Institue (Chicago) contracted with Insights West (Los Angeles) in October 1978 to conduct investigative research to identify the technical factors, management attitudes, and possible outside influences in introducing solar energy to industrial plants. Solar systems to be considered were those augmenting natural gas-fired units with process temperature needs under 550°F. The methodology consists of 200 in-plant interviews of which over 100 were completed by September 1, 1979. The interview outline is presented. Upon completion of the field interviews, process needs determined will be matched with available solar hardware and a list developed and ranked as to the Most Likely candidates for solar industrial process heat installations. A follow-on program to expedite industry's acceptance of these prime solar applications is being considered.

23914 (SERI/TP—333-429, pp 155-159) **Implications of meeting the domestic policy review's goal for solar industrial process heat in the year 2000.** Shulman, M.J. (MITRE Corp., McLean, VA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The DPR has concluded that 2.6 quads of fossil fuel can be displaced by solar agricultural and industrial process heat (AIPH) systems. A requirements analysis conducted by the MITRE Corporation indicates that to meet this goal the federal government will have to institute a 40% investment tax credit, a large field testing and information dissemination program, and rapidly develop high temperature thermal storage media. Production of collectors will have to reach 635 million square feet in 2000 if the DPR goal is to be met. There is a potential for glass and capital shortages that could inhibit the development of the solar process heat industry and the federal government may have to help eliminate these problems. Meeting the DPR goal is a difficult but not impossible task.

23915 (SERI/TP—333-429, pp 161-168) **Solar supplement to laundry drying.** Smith, C.C.; Maupoux, M. (Colorado State Univ., Fort Collins). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

A project was undertaken to develop and demonstrate solar energy used for commercial-scale laundry drying. Air is heated in flat-plate solar collectors and then supplied directly to the air intake of a standard commerical drying unit. The site chosen for this project was the Fort Collins city hospital laundry. The facility is two years old with an excellent layout for a solar retrofit installation. The dryers are next to a south wall and the southern exposure is unobscured most of the day. The collector area is 440 ft² (41 m²). The solar heated air is carried directly to the air intake of the natural gas-fired dryer and the gas burner atop the dryer serves as supplemental energy when solar availability is too low. A short-term pebble-bed storage is provided to store solar heat up to 20 minutes while the

dryer is in a cooling cycle and for reloading. The operating procedure of the laundry has not been altered due to the solar system, which has been in operation since Jan 1979. The study is aimed at determining costs of solar installation, fuel saving, and operational characteristics. Background studies indicate that solar commercial laundry drying has high potential for cost-effectiveness and the CSU project is aimed at demonstration this potential in quantitative terms.

23916 (SERI/TP—333-429, pp 169-173) **Potential for the use of solar energy in the production of process heat in Arizona.** Smith, S.E. (Univ., of Arizona, Tucson); Mignon, G.V.; Campoy, L.P.; Fazzolare, R.; Lobit, J. 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

At the University of Arizona, a survey of the potential for the use of solar energy in the production of process heat within the State of Arizona has been performed. The study, conducted for the Arizona Solar Energy Research Commission, examines the technical and economic characteristics of current process heat use within the industrial, commercial, and agricultural sectors of the State and assesses aspects of the feasibility of applications and the extent to which solar energy might displace conventional fuels for this purpose. Examination of the three sectors has revealed numerous instances in which solar applications appear technically feasibile. The economic viability has been found to be strongly influenced by fuel type and availability, duty cycles and application temperature. The greatest single factor in establishment of economic feasibility appears to be the magnitude of Federal and State tax incentives. Follow-on studies to examine the detailed technical and cost/benefit criteria for the identified applications are currently in progress.

23917 (SERI/TP—333-429, pp 181-185) **Central receiver solar energy system for an oil refinery.** Sommerlad, R.E. (Foster Wheeler Development Corp., Livingston, NJ); Zoschak, R.J.; Rogan, J.E. 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The conceptual design and economics of a central receiver solar energy system for an oil refinery scheduled to be in operation by 1983 are discussed. The system will be designed to make maximum use of existing solar thermal technology consistent with existing refinery design and operating techniques, will provide for the best possible economics for the application, and will offer the best combination of solar and fossil-fuel energy. The baseline system design consists of a tower-mounted, natural-circulation water/steam receiver with a capacity of 18.4 kg/s (146,000 lb/h). A flat-panel absorber generates saturated steam that is superheated to the desired temperature in a separate, oilfired superheater prior to admission to the main refinery superheated steam headers. The solar plant will furnish 99.3 GWht (339 x 10^9 Btu) or 20 percent of the annual refinery steam demand and will displace annually about 10.7 dam^3 (67,400 barrels) of the salable residual fuel oil produced by the refinery.

23918 (SERI/TP—333-429, pp 187-191) **Solar production of industrial process hot water.** Niemeyer, W. (Acurex Corp., Mountain View, CA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The objective of this project is to demonstrate the technical feasibility and cost-effectiveness of using solar energy to heat water for an industrial process at the Campbell Soup plant in Sacramento, California. The industrial process is a can washing operation that is part of Campbell's soup production line. A schematic of the hot water system is shown. The design is simple: water passes through the collector field once, without recirculation. Well water enters the flat plate collectors for preheating, passes through the concentrators for final heating, and is sent to a storage tank. Hot water is pumped from the storage tank to the plant upon demand. Additional heating as required is provided by a steam heat exchanger operating from the plant steam supply. Project status is reported. (WHK)

23919 (SERI/TP—333-429, pp 193-197) **Solar industrial process hot water for cement block manufacture.** Wilkening, H.A. (AAI Corp., Baltimore, MD). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

AAI Corporation is currently engaged in the Operation and Evaluation Period of a contract to design, manufacture, and test a solar assisted hot water system for curing concrete blocks. The collector system consists of 856 $meter^2$ (9216 ft^2) of AAI's 24/1 concentrating collector. The collectors are mounted on the roof of the new block manufacturing plant near Harrisburg, Pa. owned by York Building Products Co., Inc. Solar heated water is piped to the underground rotoclave or tank in which a circular steel boat floats. The heated water cures the green block contained within the slowly rotating boat. Over thirty percent of the curing energy is supplied by the solar system. This system has the potential for supplying energy for the nation's 1200 block plants which consume over a million barrels of oil annually.

23920 (SERI/TP—333-429, pp 199-204) **Operational experience of the LaFrance, South Carolina solar process hot water system.** Trice, J.B.; Herz, J.; Burns, R.C. (General Electric Co., King of Prussia, PA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

Installation of the LaFrance solar process hot water system for textile dyeing was completed in June of 1978. Since that time, operation has been continuous, except for several brief periods when the system fluid loop was refilled. During the startup and debugging phase, a number of system modifications were performed which resulted in reliability upgrading. Several problems with the Data Acquisition System have caused a significant loss in data. From the data available, the overall system performance is below design predictions. While the collector performance is about as predicted, system thermal losses are higher than expected. A number of modifications have been proposed to reduce these losses, and a contract has been awarded by DOE to implement the modification program and to extend the test period.

23921 (SERI/TP—333-429, pp 205-213) **Analysis of the operation of an industrial drying solar system.** Carnegie, E.J.; Niles, P.W.; Stine, W.B. (California Polytechnic State Univ., San Luis Obispo). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

California Polytechnic State University, San Luis Obispo, under the Industrial Process Division of the Department of Energy, assisted by TRW (Energy Systems Group) of Redondo Beach, and Pacific Gas and Electric Company, has designed, constructed, and is operating an industrial hot air raisin and prune drying system at the Lamanuzzi and Pantaleo Drying Plant in Fresno, California. The solar heating system consists of 1951 m^2 (21,000 sq. ft) of solar collectors, a 396 m^2 (14,000 cu. ft.) rock storage facility, and a heat recovery unit. The system was placed in operation during the drying season from August 1978, to mid-January, 1979, and supplied about 80% of the heating requirements for one drying tunnel.

23922 (SERI/TP—333-429, pp 215-229) **Performance of a solar heating system for kiln drying lumber.** McCormick, P.O. (Lockheed-Huntsville Research and Engineering Center, Huntsville, AL). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

A summary of the data obtained from a one-year test of a solar augmented lumber kiln in Canton, Mississippi, is presented. The test was conducted from 15 June 1978 to 12 April 1979 during which time the solar system operated 315 days and useful data were obtained for 180 days. The test system consists of two 50,000 board feet capacity kilns (conventionally heated by gas/oil direct fire burners) solar heated by water/air heat exchangers in each kiln. The solar energy is collected by 2500 ft^2 of roof mounted Chamberlain double glazed, black chrome collector (augmented by 2300 ft^2 of anodized aluminum reflector), stored in a 5000 gal steel water tank, and delivered to the kilns as required. Some details of the system installation are shown.

23923 (SERI/TP—333-429, pp 231-237) **Solar augmented soybean drying.** Hall, B.R. (Teledyne Brown Engineering, Huntsville, AL). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The objective of this overall project was to provide analysis, design, fabrication, and demonstration of a solar energy system for process drying of soybeans. The system consists of an array of 672 air collectors that preheat the inlet air to existing continuous-flow dryers at the Gold Kist Soy facility at Decatur, Alabama. This experimental system, sponsored by the US Department of Energy (DOE), has been operational since June 1, 1978. Because of soybean process equipment maintenance, a system utilization of only 54.7% was achieved. The 1,215-m^2 (13,104-ft^2) system delivered 0.867 TJ (8.225 x 10^8 Btu) or 1.3% of the energy requirement for one dryer in the first year of operation. The facility and the first year of operation and present performance, operational, and life-cycle cost analysis are presented.

23924 (SERI/TP—333-429, pp 238-243) **Application of solar energy to continuous belt dehydration.** Sierer, P.D. Jr. (Trident Engineering Associates, Inc., Annapolis, MD); Powell, D. 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The work site is located at the dehydration plant of Gilroy Foods, Inc., at Gilroy, California, a wholly-owned subsidiary of McCormick and Company. Gilroy Foods, Inc. is a major producer of dehydrated onion and garlic products. The solar system is intended to provide solar-generated heat to the drying process to supplement heat produced by conventional gasfired burners. The design

consists of a single 552.7 m^2 (5959 ft^2) collector field composed of evacuated tube collectors which use water as the heat transfer fluid. The collector modules are mounted on a warehouse roof by means of a prefabricated support structure. The final system design provided for a collector array of General Electric TC-100 evacuated tube solar collectors. The system is described and initial operating results are discussed. (WHK)

23925 (SERI/TP—333-429, pp 245-249) **Textile drying at West-Point Pepperell using solar process steam.** Mitchell, P.D. (Honeywell, Inc., Minneapolis, MN). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

A solar process steam system for providing process heat to a textile drying process has been designed and installed at the West-Point Pepperell MARTEX towel mill in Fairfax, Alabama. The system consists of five major subsystems: the collector field, the high temperature water loop, the steam generator, the steam loop, and the process. The collector field consists of 24 parabolic trough, single axis tracking, concentrating collectors. The high temperature water loop is the piping which transports the solar energy from the collector field to the steam generator. The steam generator is a commercially available unfired package boiler. The steam loop is the piping which transports the solar steam to the process, and returns the condensate back to the boiler as feedwater. The process being solarized is a line of slashers which use steam heated drying cans to dry the textiles. The system is designed to generate 380°F water at the collector outlet to feed the steam generator. The steam generator will provide 76 psi (320°F) steam to the process. Under peak insolation conditions, the system is expected to deliver 1,000 lbs. of steam to the process. Computer simulations using local weather data indicate that the system will deliver about 10^9 Btu's to the process annually.

23926 (SERI/TP—333-429, pp 251-256) **Solar production of industrial process steam.** Youngblood, S.B. (Acurex Corp., Mountain View, CA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The objective of this project is to demonstrate the technical and economic feasibility of generating indistrial low pressure steam with solar energy at the Johnson and Johnson manufacturing plant in Sherman, Texas. Acurex has designed a system employing 1070 m^2 (11,520 ft^2) of Acurex Model 3001 parabolic trough collectors in which pressurized water circulates directly through the collector, reaching temperatures as high as 490°K (420°F) before being throttled into a flash boiler. Water in the boiler flashes to steam to supply the plant steam main. The design for this project was completed in June 1978. Construction began in April 1979 and was completed in September 1979. Startup and checkout of the facility is scheduled for completion in November of this year. This will be followed by a 15 month evaluation of system operation and performance.

23927 (SERI/TP—333-429, pp 257-261) **Solar production of industrial process steam for The Home Laundry.** Eldridge, B.G. (Jacobs-Del Solar Systems Inc., Pasadena, CA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

Commercialization of solar energy for industrial purposes is an attractive goal in light of current concern over air pollution and the availability and cost of fossil fuels. A project at The Home Laundry in Pasadena, California, has been designed to demonstrate the technical and economic feasibility of utilizing a solar system in a process heat application. This Jacobs-Del project is currently under construction and will be operational by February 1980. The principal problem encountered in connection with the project to date has been of an institutional nature; in the State of California, property taxes on a solar system often exceed the dollar value of any fuel savings. Recommendations for legislative reform on this issue have now been formulated for proposal to the State of California.

23928 (SERI/TP—333-429, pp 263-265) **Solar production of low pressure steam for processing of orange juice.** Trice, J.B. (General Electric Co., King of Prussia, PA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

Fabrication of the system components is in process, and initial installation operations are underway at the Bradenton, Florida plant site. Construction is expected to be completed in January 1980. Following startup and checkout, a 15 month evaluation phase is currently planned to obtain data for quantifying system performance. The principal use of the solar energy is for thawing large blocks of frozen orange juice held in cold storage at Tropicana. During weekends, when the thawing operation is shut down, the collected energy will be used to remove moisture from a glycol concentrator and for cold storage refrigeration. With this dual usage, the need for thermal energy storage is eliminated, resulting in a simpler and less expensive system. The General Electric non-tracking concentrator (2.9:1) collector was selected for this application in order to provide the simplest, most reliable collector for the temperature required. Instead of a continuous tracking system, the collector is manually adjusted four times a year to an appropriate tilt angle. This results in an overall efficiency that is within 2% of that which could be obtained by single axis continuous tracking. The collector area is 929 square meters (10,000 square feet).

23929 (SERI/TP—333-429, pp 267-272) **Application of solar energy for the generation and supply of industrial process low to intermediate pressure steam ranging in temperature from 300°F to 550°F.** Yasuda, A.K. (Acurex Corp., Mountain View, CA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The objective of this project is to demonstrate the technical and economic feasibility of generating high temperature (300 to 550°F) industrial process heat. In this, application, solar energy is used to heat No. 6 oil stored in a 120,000 barrel bulk storage tank. Heating is required to reduce the viscosity of the oil so it can be pumped into and out of bulk storage. ERGON is currently firing fossil fuels to provide the required 450 to 535°K (350 to 500°F) process heat. This process is an excellent thermal application for solar energy, and has widespread applicability in the oil industry. The system design combines off-the-shelf hardware with a simple plant interface that results in minimum installed and operating costs. Design and analysis of this project was completed in June 1979. Additional funding for construction has not been awarded.

23930 (SERI/TP—333-429, pp 273-275) **Solar production of industrial process steam at Dow Chemical Company's Dalton, Georgia, Latex Manufacturing Plant.** Gupta, G.D. (Foster Wheeler Development Corp., Livingston, NJ). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

This solar system is designed to generate industrial process steam at 1034 kPa (150 lb/in^2) gage for Dow Chemical Company's Latex Manufacturing Plant in Dalton, Georgia. The project is intended to develop a demonstration unit consisting of 929 m^2 (10,000 ft^2) of solar collector surface area. Downtherm LF is used as the intermediate heat-transfer fluid which is circulated in the primary loop through Suntec-Hexcel parabolic trough collectors to a boiler and then back to the collectors via a circulating pump. The system is expected to generate 2677 GJ (2536 x 10^6 Btu) annually.

23931 (SERI/TP—333-429, pp 277-282) **Solar production of industrial process steam (NL Industries, Inc. Project; Newberry Springs, California).** Eldridge, B.G. (Jacobs-Del Solar Systems, Inc., Pasadena, CA)). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

A concept design analysis was performed to evaluate the technical and economic feasibility of the solar production of industrial process steam for an NL Industries, Inc. project at Newberry Springs, California, which processes hectorite ore. A solar system was proposed which included 10,240 sq. ft. of Del, single-axis, tracking, parabolic-trough, concentrating collectors. Potential problems with system freezing and collector maintenance were anticipated and skirted. It ia estimated that implementation of this system would result in an annual savings of 3,356 Btu, or the equivalent of 600 barrels of oil.

23932 (SERI/TP—333-429, pp 283-320) **High temperature process steam application at the Southern Union Refining Company (solar energy in the oil patch).** (Energetics Corp., Richardson, TX). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

Design considerations and performance analysis of a solar process steam system for Southern Union Refining Company's Famariss Energy Refinery are presented. The proposed system utilizes 10,080 ft^2 of parabolic trough collectors. (WHK)

23933 (SERI/TP—333-429, pp 321-325) **Solar production of industrial process steam for the Lone Star Brewery.** Deffenbaugh, D.M. (Southwest Research Inst., San Antonio, TX). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The detailed design and system analysis of a solar industrial process steam system for the Lone Star Brewery is outlined. The industrial plant has an average natural gas usage of 12.7 MMcf per month. The majority of this energy goes to producing process steam of 125 psi and 353°F at about 50,000 lb/hr. Since the maximum steam production of the solar energy system is about 1700 lb/hr, the industrial process can accept all of the solar-produced steam. The solar steam system will consist of 9450 ft^2 of Solar Kinetics T-700 collectors arranged in fifteen 90-ft long rows through which 67.5 pgm of Therminol T-55 is pumped. This hot Therminol then transfers the heat collected to a Patterson-Kelley Series 380 unfired steam boiler. The solar-produced steam is then metered to the industrial process via a standard check valve.

23934 (SERI/TP—333-429, pp 327-334) **Solar production of industrial process steam for Stauffer Chemical Company.** Kast, M.; Ortiz, P.; Whitehouse, H. (Pacific Sun Inc., Palo Alto, CA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

A solar steam-generation facility has been designed for Stauffer Chemical's Henderson, Nevada production complex under the auspices of DOE's Industrial Process Heat Program. The design features a 984 m^2 (10,592 ft^2) array of line-focusing parabolic collectors which directly heats pressurized water. Saturated steam at 187°C (368°F) and 1170 kPa (170 psia) is produced by means of a flash separation step. A peak steam flow rate of 900 kg/hr (2000 lbm/hr) is expected, with annual production totaling 1.5 x 10^6 kg (3.4 x 10^6 lbm).

23935 (SERI/TP—333-429, pp 335-342) **Solar production of industrial process steam for potato frying.** Cherne, J. (TRW Energy Systems Group., Redondo Beach, CA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

TRW is developing application of solar industrial process heat to food processing at the Ore-Ida Foods plant in Ontario, Oregon, under the auspices of the Department of Energy. In the just completed Phase I, conceptual design studies and the detail design of the system were performed. The end use of the energy is steam at 417°F, 300 psi, heating oil through a heat exchanger to fry potatoes. The system selected consists of high efficiency, parabolic trough concentrating collectors generating hot water at 480°F feeding a flash tank which generates steam at 417°F. The steam from the flash tank interfaces with the plant process steam through a simple connection into the steam lines. The design of the system is modular such that it can be augmented to provide whatever requirements are desired. Application to any industrial process using fossil-fired boilers to produce steam is easily accomplished. Current activities include construction of a 10,000 sq ft array of collectors on the roof of the Ore-Ida potato processing plant. Construction will be completed in June 1980. This system is expected to collect 2.5 x 10^9 Btu of energy which will produce a net of 1.9 x 10^9 Btu/year of steam, equivalent to 2.3 x 10^6 cu ft of natural gas. Production schedules inthe plant will result in a steam consumption of 1.3 x 10^9 Btu/year.

23936 (SERI/TP—333-429, pp 343-354) **Solar collector and industrial heat pump system for process hot water for an aluminum anodizing line.** Rost, D.F. (Solar Energy Engineering, Poland, OH); Ameduri, G.J.; Alexander, C.K. Jr.; Schuler, H.F. 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

General Extrusions, Inc., Youngstown, Ohio and Solar Energy Engineering, Poland Ohio, have designed an industrially-oriented solar collector. They designed and constructed a system utilizing 4,400 square feet of these collectors and a specially-designed Westinghouse Templifier industrial heat pump to heat the alkaline-clean tank of GEI's anodizing line. Work was initiated on this project in the summer of 1976 and completed in September 1977. The system is capable of producing over 500,000 Btu/hr (146 kW) at 190°F (88°C) during a sunny noontime. The system is described.

23937 (SERI/TP—333-429, pp 355-371) **Overview of solar pond technology.** Sargent, S.L. (Dept. of Energy, Golden, CO). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

An overview of the current technology of solar ponds is presented, with emphasis on salt gradient ponds. The current pond programs of both the United States and Israel are described, and several proposed US/Israel cooperative pond projects are discussed. Possible pond applications to industrial processes are explored, leading to the conclusion that under appropriate conditions, ponds are a highly promising method of collecting and storing solar energy for industrial process heat (IPH).

23938 (SERI/TP—333-429, pp 385-390) **Point-focus collector technology for IPH.** Lucas, J.W. (Jet Propulsion Lab., Pasadena, CA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The point-focusing distributed receiver concept utilizes a parabolic concentrator which tracks the sun in two axes across the sky. The concentrator collects sunlight from a large area and reflects and focuses it to a very small area. A receiver, which is mounted at the focal point, captures the concentrated radiation and converts the energy to heat in a working fluid such as hot gas or steam. The working fluid transports the energy via flexible lines to a heat-transfer network on the ground to provide process heat. The technology status of the basic concentrator and receiver subsystems is described.

23939 (SERI/TP—333-429, pp 415-431) **IPS system configurations.** Whitehouse, H.T. (Pacific Sun Inc., Palo Alto, CA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

An overview of Industrial Process Heating (IPH) system configurations is provided. The selection of a configuration is shown to be affected by the nature of the end process served, the delivery temperatures involved, and the peculiarities of the local plant environment and staffing. Proper identification of valid solar tasks within a given plant is emphasized using Second Law criteria. Particular examples are cited in the discussion of each generic system type. 46 references.

23940 (SERI/TP—333-429, pp 439-444) **Economic analysis of solar industrial process heat systems: a methodology to determine annual required revenue and internal rate of return.** Dickinson, W.C. (Lawrence Livermore Lab., CA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

To permit an economic evaluation of solar industrial process heat systems, we have developed a methodology to determine the annual required revenue and the internal rate of return. First the methodology is briefly outlined presenting the basic cost equations. Then the methodology is applied to determine the level of government tax and load incentives that will probably be necessary to make solar IPH systems economically attractive to industry.

WATER HEATING

REFER ALSO TO CITATION(S) 23877, 23895, 23902, 23953

23941 (SOLAR/2028—78/14) **Solar energy system performance evaluation, Hogate's Restaurant, Washington, DC, June-August, 1978.** Aquila, V.S. (International Business Machines Corp., Huntsville, AL (USA)). 1978. Contract AC01-79CS30027. 43p. NTIS, PC A03/MF A01.

This system is designed to provide hot water on demand for the kitchen facilities located at Hogate's Restaurant. Presented are results of an evaluation of measured system performance and a comparison of measured climatic data with long term average conditions. Performance evaluations of each major subsystem are also presented. A brief system description, review of actual system performance during the report period, analysis of performance based on evaluation of climatic, load and operational conditions, and an overall discussion of the results of analysis are included. The solar energy system operated satisfactorily for the reporting period. The average incident solar energ was 260 million Btu per month of which 90 million Btu were collected resulting in a collector array efficiency of 34 Btu were collected resulting in a collector array efficiency of 34%. Solar energy collection and utilization are approximately in phase at Hogate's Restaurant. This, coupled with the high rate of water consumption of 7000 gallons per day, results in a 97% storage tank efficiency. The average monthly thermal load is 130 million Btu of which 63% is satisfied by the solar energy system.

23942 **Experience with solar heating.** Heidbrier, W.G. (A.Y. McDonald Mfg. Co., Dubuque, IA). pp 3-4 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

The installation of an 80 gallon solar water heater utilizing two 4 x 8 solar panels and a drain down system is described. Operating experience is reviewed. (MHR)

23943 **Design and evaluation of solar powered residential domestic water heaters.** McKilligan, K.J.; Wilcox, G.L. (Chamberlain Mfg., Waterloo, IA). pp 10-14 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

Prototype retrofit and new construction solar augmented domestic hot water (DHW) systems were designed and fabricated for operational testing in Waterloo, Iowa. Two systems were designed and components sized to meet the Department of Housing and Urban Development (HUD) Minimum Property Standards for an average family of four persons. The two systems were operated side by side under actual local climatic conditions and simulated hot water usage. The systems now have been operational for a period of more than 17 months with data evaluation and monitoring throughout the period. The actual operating conditions were found to agree very closely with those predicted based upon theoretical weather characteristics provided for Waterloo. Either version, new construction or retrofit, should provide approximately 42% of the annual domestic hot water requirements of a family of four livng in Waterloo, Iowa. Likewise, systems located in more favorable sun locations, such as Phoenix, Arizona, should find as much as 76% of the service load satisfied by solar energy.

23944 **Innovative double walled heat exchanger for use in solar water heating.** Mumma, S.A.; Milnarist, L.P.; Rodriguez-Anza, J.M. (Arizona State Univ, Tempe). pp 7-11 of Thermal storage and heat

transfer in solar energy systems. Kreith, F.; Boehm, R.; Mitchell, J.; Bannerot, R. (eds.). New York, NY; American Society of Mechanical Engineers (1978).

From ASME meeting; San Francisco, CA, USA (10 Dec 1978).

In liquid solar space heating and water systems located in freezing climates, it is necessary that a satisfactory means of freeze protection be incorporated into the design. Several means of achieving this protection are: (1) using a drain down system; (2) using a recirculation pump system; (3) providing some sort of freeze protection within the solar collector; (4) using an anti-freeze water solution; (5) in lieu of water, using a heat transfer fluid, such as oil. The authors of this paper believe that the most fail-safe methods of freeze protection are the latter two, with the anti-freeze water solution being slightly favored because of its higher heat transfer capabilities, and lower pumping energy requirements. The toxic nature of the anti-freeze water solution makes it imperative that it be used with a double walled heat exchanger to prevent a health hazard and also to comply with the Uniform Solar Pluming Codes which are being adopted by cities, towns and municipalities. It is proposed that a standard fin tube water to air heat exchanger be adopted for use as a double walled heat exchanger. Heat exchanger design and test results are discussed. (WHK)

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 23825, 23859, 23893, 23938, 23975, 24395

23945 (ALO—3977-5) **Solar pond studies: Phase III. Fifth semi-annual progress report to the US Department of Energy.** Bryant, H.C.; Rothmeyer, M.K. (New Mexico Univ., Albuquerque (USA). Dept. of Physics and Astronomy). 10 Jan 1980. Contract EG-77-S-04-3977. 125p. Dep. NTIS, PC A06/MF A01.

The diffusion equation for salt gradient solar ponds has been modified to include the Soret effect (a thermal cross-effect due to the temperature gradient). The contribution of the Soret effect to the diffusion flux of salt is shown to be on the order of 4% in the winter and 28% in the summer for the UNM NaCl solar pond. The traditional stability criterion for solar ponds remains practically unchanged by the Soret effect. However, the contribution of non-constant properties (diffusion coefficient, thermal diffusivity and viscosity) - which have been neglected so far - seems to be significant. Saturated solar ponds are described by a system of differential equations which include the Soret effect, the formation and redissolving of crystals. The analytical solutions of this system are given for the steady-state and constant properties. A laboratory experiment using KNO_3 confirms the existence of a stable saturated gradient. Temperatures of up to 90°C and temperature gradients of up to 2°C/cm were used in the experiment without any sign of convective layers. A saturated gradient at steady state includes a super saturated region close to the surface which results in the fallout of crystals in that region. The diffusion flux of salt is thus balanced by a flux of crystals downwards and the net flux of salt is zero in a steady state.

23946 (ALO—4123-T1) **Development of a site-fabricated building integrated air collector. Third quarterly report, March 31-June 30, 1978.** Kohler, J.T.; Temple, P.L.; Sullivan, P.W. (Total Environmental Action, Inc., Harrisville, NH (USA)). 31 Jul 1978. Contract EG-77-G-04-4123. 49p. NTIS, PC A03/MF A01.

Total Environmental Action, Inc. is developing a cost-effective, site-fabricated, building-integrated air solar collector. The specific tasks are: (1) assessment of existing site-fabricated solar air heaters, (2) assessment of material availability, (3) analysis of site-fabricated air heater performance, (4) analysis of cost and building integration, (5) assessment of collector reliability and durability, (6) design and construction of an optimized collector, (7) experimental testing, (8) final design, (9) regional economic and performance projections, and (10) production and dissemination of application and evaluation documents and required reports. Tasks 1 and 2 have been completed and the results published. Tasks 3, 4, and 5 are divided into three phases: (1) evaluation of alternative collector designs, (2) optimization of the best design, and (3) experimental testing and validation of the theoretical analysis. The second phase of these tasks is nearly completed. The effects of (1) air mass flow rate, (2) collector length, (3) collector channel size, (4) paint emissivity, (5) insulation, and (6) alternative glazing configurations on collector performance have been analyzed. In addition, procedures to determine the optimum air flow rate, collector length and channel size based on specified applications have been developed. The results are presented and discussed. The material and labor costs of Designs 1 and 3 have been refined based on (1) information obtained during the construction of the test collectors and (2) documentation of an actual installation of a Design 1 collector on a home in Putney, Vt. These results are presented. The test program is presently underway. Preliminary results are discussed.

23947 (ALO—4123-T2) **Development of a site-fabricated, building integrated air collector. Quarterly technical progress report, September 30, 1977-December 31, 1977.** Coleman, J.J.; Kohler, J.T.; Temple, P.L.; Sullivan, P.W. (Total Environmental Action, Inc., Harrisville, NH (USA)). 20 Jan 1978. Contract EG-77-G-04-4123. 55p. NTIS, PC A04/MF A01.

Total Environmental Action, Inc. is presently developing a cost-effective, site-fabricated, building-integrated air solar collector. The specific tasks are: (1) assessment of existing site-fabricated solar air heaters, (2) assessment of material availability, (3) analysis of site-fabricated air heater performance, (4) analysis of cost and building integration, (5) assessment of collector reliability and durability, (6) design and construction of an optimized collector, (7) experimental testing, (8) final design, (9) regional economic and performance projections, and (10) production and dissemination of application and evaluation documents and required reports. The questionnaire to assess existing site-fabricated solar air heaters has been formulated and mailed. The materials survey is about half completed. Collector performance and building integration are generally proceeding satisfactorily. The approach has been outlined in detail. Three (of eight) alternative collector designs have been specified. The first has been costed and preliminary performance calculations have been made for the design. It has become apparent that it is not possible to do a satisfactory dissemination of the collector design without considering the rest of the system (load, storage, controls, etc.). Reliability of collector designs has been incorporated into material assessment and building integration. The test program has been formulated.

23948 (ALO—4123-T3) **Development of a site-fabricated, building integrated air collector. Interim report, September 30, 1077-March 31, 1978.** Kohler, J.T.; Temple, P.L.; Colemen, J.J.; Sullivan, P.W. (Total Environmental Action, Inc., Harrisville, NH (USA)). 28 Apr 1978. Contract EG-77-G-04-4123. 112p. NTIS, PC A06/MF A01.

Total Environmental Action, Inc. is developing a cost-effective, site-fabricated, building-integrated air solar collector. The specific tasks are: (1) assessment of existing site-fabricated solar air heaters, (2) assessment of material availability, (3) analysis of site-fabricated air heater performance, (4) analysis of cost and building integration, (5) assessment of collector reliability and durability, (6) design and construction of an optimized collector, (7) experimental testing, (8) final design, (9) regional economic and performance projections, and (10) production and dissemination of application and evaluation documents and required reports. The questionnaires to assess existing site-fabricated solar air heaters have been analyzed and the materials survey has been completed: the results are described. Seven site-built collector designs have been specified and analyzed with respect to performance, cost, building integration, reliabilty, and aesthetics. Two of these designs have been selected for further analysis. The least expensive design can be constructed at a cost of $\$36/m^2$ and will provide 1.16×10^6 kJ/m^2 in Boulder acccording to an f-chart analysis. The test program has been formulated, five test collector modules have been designed, and materials have been ordered.

23949 (ALO—4150-12) **Draining of the SUNPAK/sup TM/ evacuated tubular collector.** Pei, Y.K. (Owens-Illinois, Inc., Toledo, OH (USA). Solar Energy Products Group). May 1980. Contract EG-77-C-04-4150. 62p. NTIS, PC A04/MF A01.

A program has been completed which demonstrates the capability of draining the present liquid series flow SUNPAK/sup TM/ evacuated tubular collector. The benefits which are derived include the avoidance of potential problems associated with liquid boil-out during system failure and the avoidance of collector freeze up. Additional benefits derived from a fully drained collector are the avoidance of significant heat losses during overnight periods, safe access to the collector for maintenance at any time and ability to dissipate excess heat through dry stagnation of the collector during shut down periods. A simple modification to the series flow SUNPAK/sup TM/ collector module arrangement was developed and demonstrated through the full scale testing of a two bank-six module arrangement. The necessary changes can be implemented at a minimum expenditure of time and cost. The extensive field service experience which has been accumulated with the liquid series flow SUNPAK/sup TM/ collector is directly applicable to the drainable configuration. The program included the investigation of an alternate approach to the series flow SUNPAK/sup TM/ solution. The intra module parallel flow concept was demonstrated through the proof of concept phase of effort. The solution investigated incorporated a batch flow rather than a continuous flow mode of the cooling fluid. The solution required an extensive design modification of the existing SUNPAK/sup TM/ collector manifold. During the redesign effort, other desired mechanical features of the manifold were incorporated to improve the physical characteristics, to improve safety and reliability and to reduce the potential cost of future SUNPAK/sup TM/ collector arrays.

23950 (COO—2608-3) **Evacuated tubular collector utilizing a heat pipe. Final report, August 1-September 30, 1977.** Ortabasi, U.

(Corning Museum of Glass, NY (USA)). 1977. Contract EY-76-C-02-2608. 60p. Dep. NTIS, PC A04/MF A01.

The evaluation of three evacuated tubular solar collector designs is reported: heat pipe cusp; counter flow cusp; and counter flow/flat plate. Comparative field testing of 4' x 4' modules was completed for all three designs. Thermal analysis of data shows that the evacuated heat pipe/cusp collector is a viable concept, more suitable for medium to high temperatures and high solar flux intensities.

23951 (DOE/CS/34163—2) **Image collapsing concentrators. Interim scientific report No. 2.** Sletten, C.J. (Solar Energy Technology, Inc., Bedford, MA (USA)). 20 Jan 1980. Contract FG04-77CS34163. 40p. NTIS, PC A03/MF A01.

A cylindrical Fresnel-type lens has been designed and ray traced that focuses approximately to lines over a 60° elevation angle interval. Forty stepped prism facets are configured on the inside surface of the lens, and the lens outer surface can be well approximated by a smooth circular arc. Especially contoured cylindrical subreflectors are described for concentrating the broad image fields of the lens onto a narrow fixed shelf. These image collapsing subreflectors also compensate for focal shortening with azimuth angle incidence variations over nearly a +-60° sector. Ray tracing on the lens and subreflector provide approximate energy distributions on the absorber shelf over the large acceptance angle intervals. The expected performance characteristics of a solar concentrator using the curved lens with facets on the inside surface are compared with a concentrator employing a straight stepped prism lens with facets cut on the outer lens surface.

23952 (LA-UR—80-852) **Active solar collector and materials research.** Neeper, D.A. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 3p. (CONF-800340—1). Dep. NTIS, PC A03/MF A01.

From DOE active solar heating and cooling contractors' review meeting; Lake Tahoe, NV, USA (26 Mar 1980).

Work completed on various collectors is listed. (MHR)

23953 (MLM—2702(OP)) **Evaluation of solar pond performance.** Wittenberg, L.J. (Mound Facility, Miamisburg, OH (USA)). 1980. Contract EY-76-C-04-0053. 2p. (CONF-800340—3). Dep. NTIS, PC A02/MF A01.

From DOE active solar heating and cooling contractors' review meeting; Lake Tahoe, NV, USA (26 Mar 1980).

The City of Miamisburg, Ohio, constructed during 1978 a large, salt-gradient solar pond as part of its community park development project. The thermal energy stored in the pond is being used to heat an outdoor swimming pool in the summer and an adjacent recreational building during part of the winter. This solar pond, which occupies an area of 2020 m^2 (22,000 sq. ft.), was designed from experience obtained at smaller research ponds located at Ohio State University, the University of New Mexico and similar ponds operated in Israel. During the summer of 1979, the initial heat (40,000 kWh, 136 million Btu) was withdrawn from the solar pond to heat the outdoor swimming pool. All of the data collection systems were installed and functioned as designed so that operational data were obtained. The observed performance of the pond was compared with several of the predicted models for this type of pond. (MHR)

23954 (SAND—79-2371C) **Survey of selective solar absorbers and their limitations.** Mattox, D.M.; Sowell, R.R. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 25p. (CONF-800530—1). NTIS, PC A02/MF A01.

From International conference on materials for photothermal energy conversion; Corsica, France (6 May 1980).

A number of selective absorber coating systems with high solar absorptance exist which may be used in the mid-temperature range. Some of the systems are more chemically and thermally stable than others. Unfortunately, there are large gaps in the stability data for a large number of the systems. In an inert environment, the principle degradation mechanisms are interdiffusion between the layers or phases and changes in surface morphology. These degradation mechanisms would be minimized by using refractory metals and compounds for the absorbing layer and using refractory materials or diffusion barriers for the underlayer. For use in a reactive environment, the choice of materials is much more restrictive since internal chemical reactions can change phase compositions and interfacial reactions can lead to loss of adhesion. For a coating process to be useful, it is necessary to determine what parameters influence the performance of the coating and the limits to these parameters. This process sensitivity has a direct influence on the production process controls necessary to produce a good product. Experience with electroplated black chrome has been rather disappointing. Electroplating should be a low cost deposition process but the extensive bath analysis and optical monitoring necessary to produce a thermally stable produce for use to 320°C has increased cost signficantly. 49 references.

23955 (SERI/TP—333-429, pp 87-89) **Solar tracking system for line focusing collectors.** Carlton, R.; Luddy, W. (Acurex Corp., Mountain View, CA). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

Acurex Corporation has developed a sophisticated uniaxial tracking system with primary application to line focusing collectors for industrial process heat generation. The patented system consists of a solid-state logic module and sensor, as well as an innovative direct monitoring device. Emphasis was placed on performance, cost, durability, and compatibility with various types of drives and control systems. Tracking accuracies of better than +- 1/20 degree are typical. By using a special sensor device, cloud tracking was eliminated and labor-intensive installation was minimized. Design criteria and product information are presented. In addition, the internationally compatible signal interfaces and the priority setting control logic are described.

23956 (SERI/TP—333-429, pp 133-137) **Test experience at the DOE/Sandia Midtemperature Solar Systems Test Facility.** McCulloch, W.H. (Sandia Labs., Albuquerque, NM). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

Since 1972, Sandia Laboratories, Albuquerque, NM, has been involved in the study, design construction, testing, and evaluation of solar energy systems. Some of the insights and experience acquired during this period are presented. The intent is to include only those conclusions that can be supported by actual hardware experience at the DOE/Sandia Midtemperature Solar Systems Test Facility.

23957 (SERI/TP—333-429, pp 139-143) **Low temperature industrial process heat from non-convecting solar ponds .** Ochs, T.L.; Bradley, J.O. (Desert Research Inst., Boulder City, NV). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

A unique class of integrated solar collector/storage concepts are described. A variety of non-convecting solar ponds are surveyed and ranges, performance, and costs are discussed.

23958 (SERI/TP—333-429, pp 373-383) **Technology assessment: line-focus concentrators.** Banas, J.F. (Sandia Labs., Albuquerque, NM). 1979.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The major engineering problems and near-term development emphasis for line-focus concentrators based on experiences at Sandia Laboratories are discussed. Performance, durability, and mass production capabilities are emphasized. Reflective materials, solar receivers, selective coatings, trackers, drives, wind loads, and foundations are discussed. (WHK)

23959 (SERI/TP—334-478) **Summary of solar experience with the soiling of optical surfaces.** Call, P.J. (Solar Energy Research Inst., Golden, CO (USA)). Feb 1980. Contract EG-77-C-01-4042. 15p. Dep. NTIS, PC A02/MF A01.

The results of a workshop held on July 16-17, 1979 to discuss available experimental data, current and planned experimental investigations, directly applicable optical principles, and relevant theory are summarized. The summary is in terms of the magnitude of effects on various types of systems and the effects of location, surface properties, and natural/artificial removal. The economics of prevention, tolerance, and removal are also summarized. (MHR)

23960 (SERI/TP—334-565) **Properties of a solar alumina-borosilicate sheet glass.** Coyle, R.T.; Lind, M.A.; Shelby, J.E.; Vitko, J.; Shoemaker, A.F. (Solar Energy Research Inst., Golden, CO (USA)). Jan 1980. Contract EG-77-C-01-4042. 15p. (CONF-800705—1). NTIS, PC A02/MF A01.

From 12. international glass congress; Albuquerque, NM, USA (6 Jul 1980).

Solar energy applications place unique requirements on sheet glass including very low solar absorption, outstanding stability of absorption in the outdoor environment, low cost, and elastic formability for making concentrating mirrors. The Solar Energy Research Institute and Corning Glass Works have developed a new solar sheet glass. In evaluations reported the new glass has shown outstanding chemical durability and optical and mechanical properties.

23961 (SERI/TP—641-619) **National solar optical materials program plan: an overview.** Masterson, K.D. (Solar Energy Research Inst., Golden, CO (USA)). Mar 1980. Contract EG-77-C-01-4042. 6p. (CONF-800207—3). NTIS, PC A02/MF A01.

From SPIE meeting; North Hollywood, CA, USA (4 Feb 1980).

A coordinated national program is being formulated to adapt and develop optical materials to support a goal of meeting 20% of our national energy needs with solar by the year 2000. The program contains elements covering absorber, reflector, and transmitter materials but no photovoltaic materials. These elements include research

on glass and polymer materials for glazing and reflector components, environmental testing, and long-term reliability modeling. Program subelements that support R and D and encourage commercialization of new products are also discussed. An overview of the proposed funding levels is presented.

23962 (SERI/TR—8052-1) **Heliostat production evaluation and cost analysis.** Britt, J.F.; Shulte, C.W.; Davey, H.L. (General Motors Corp., Warren, MI (USA)). Dec 1979. Contract EG-77-C-01-4042. 350p. NTIS, PC A15/MF A01.

The primary objective of this study is to provide a factory cost for the production of heliostats in terms of 1979 dollars. Factory cost is defined as the sum of all direct labor, direct material and burden expenses that are incurred in the manufacture of a heliostat, and its packaging for shipment. Transportation, installation, taxes other than plant real taxes, profit, selling expenses, and all other profit and loss items are not included. Two production volumes are considered, 25,000 heliostat units per year and 250,000 heliostat units per year. The study concluded that the factory cost to manufacture heliostats is $95.99/m^2 at 25,000 units per year and $67.95/m^2 at 250,000 units per year. The Policy Analysis Branch of the Solar Energy Research Institute estimates that this implies an installed price of $122.12/m^2 at the 25,000 unit-per-year volume.

23963 **Solar heat roofing system.** Blakey, B.H.; Pohl, D.R. (to Western Marine Electronics, Inc.). US Patent 4,174,703. 20 Nov 1979. Filed date 31 May 1977. 6p.

A solar heat roofing system including a plurality of waterproof heat absorbing panels covering substantially the entire roof of a building is described. The panels are formed by a pair of waterproof sheets connected to each other by elongated spacers which form channels for the transfer fluid. The ends of the panels fit into elongated slots formed in inlet and outlet manifolds by linear, laterally projecting flanges. The manifolds, which are also secured to the roof, contain a fluid conduit communicating with the slots. Consequently, heat transfer fluid flowing into the inlet manifold conduit flows through the fluid channels in the panel where heat is absorbed, and the transfer fluid then flows from the outlet manifold conduit to a heat utilization device. 4 claims.

23964 **Solar concentrator.** Simpson, J.G. (to National Aeronautics and Space Administration). US Patent 4,173,397. 6 Nov 1979. Filed date 30 Nov 1977. 6p.

An improved solar concentrator is described which is characterized by a plurality of elongated supporting members arranged in substantial horizontal parallelism with the axis thereof intersecting a common curve and a tensioned sheet of flexible reflective material disposed in engaging relation with the supporting members for imparting to the tensioned sheet a catenary configuration. 4 claims.

23965 **Concentrating solar heat collector.** Fattor, A.P. US Patent 4,173,214. 6 Nov 1979. Filed date 15 Aug 1977. 8p.

A stationary reflecting type solar radiation collector is described which includes a series of parabolic trough reflecting surfaces, each positioned to reflect incoming solar radiation in a generally vertical direction so as to form a concentrated line focus onto the overhanging collector heat systems. These are arranged to provide heat collection at different seasons of the year as the focused line of heat energy moves horizontally with the changing angle of the sun. In one form, a heat storage unit is integrated with the collection unit providing a heat supply in off-sun times, and includes movable insulation means arranged to provide insulation during off-sun times for the heat storage unit. 8 claims.

23966 **Solar power system, with high concentration, linear reflective solar panels.** Kelly, D.A. US Patent 4,173,213. 6 Nov 1979. Filed date 15 Sep 1976. 10p.

A solar power system with high concentration linear reflective solar panels of the linear parabolic type is described which increases the electrical power output from conventional silicon solar cells and heats water for steam power. The solar power system may be arranged as an all electric type using continuous lines of silicon solar cells located at the apex or focal zone of the parabola, or may be designed as a dual solar conversion system with both solar photoelectric means and a water heating steam means, as an indirect or secondary power source. The key feature of the system is the geometric configuration of the linear parabolic reflectors, with an unusually high reflective concentration ratio of 10:1 minimum, plus boosters, and the connection of these pivoted linear panels to a common oscillating linkage and timing unit for full sun following capability to maintain optimum direct solar exposure each day. 8 claims.

23967 **Solar radiation collector and water cooler.** Wiegand, J.B. (to Solar Energy Research Corp.). US Patent 4,173,253. 6 Nov 1979. Filed date 20 Mar 1978. 10p.

A solar radiation collector of the type having an enclosed cavity is described. A spray of water in this cavity is directed against a solar absorption sheet to heat the water. This structure may be used as a cooler by directing a flow of air through the cavity. 12 claims.

23968 **Solar panel.** Schriefer, A.H. Jr. US Patent 30,136. 6 Nov 1979. Filed date 25 May 1978. 6p.

A solar collector for use in receiving solar radiation and converting the same to heat is described. A matrix of plural layers of slit-and-expanded sheets are contained within the solar collector and the heat produced by the matrix absorbing solar radiation is transferred by convection into a forced fluid path. The surfaces of the slit-and-expanded sheets are coated to absorb and convert the radiant energy to heat and the various layers are relatively positioned at 90° to provide improved tracking of the sun in its diurnal path, the sheets having unidirectional raised portions to more efficiently absorb the sun's rays. A reflective surface behind the matrix reflects solar energy back into the matrix. A fluid, usually air, is heated by convection as it is forced through the matrix in the solar collector.

23969 **Thermogram analysis of several solar collector arrays.** Tinklenberg, R. pp 5-9 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

Five collector arrays at different locations in Iowa were surveyed using a Hughes Probeye Infrared Viewer. It was concluded that infrared thermography can identify balancing and heat removal problems, spot certain types of leaks, and help to troubleshoot in general. (MHR)

23970 **Open backflow system.** Noble, H.D. pp 22-23 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

A flat plate collector made of black corrugated steel sheet with water injected onto the back side of the metal surface is described. Two layers of tempered glass are used for the collector cover. (MHR)

23971 **Optics of nonimaging concentrators. Light and solar energy.** Welford, W.T.; Winston, R. New York, NY; Academic Press Incorporated (1978). 210p.

The optical principles for designing nonimaging concentrator are described in detail. Topics include concentrators and their uses; some basic ideas in geometrical optics; some designs of image-forming concentrators; nonimaging concentrators: the compound parabolic concentrator; developments and modifications of the basic compound parabolic concentrator; development of the compound parabolic concentrator for nonplane absorbers; shape tolerances for concentrators; applications to solar energy concentration; and applications of nonimaging concentrators to purposes other than solar energy collection. The appendices include derivation and explanation of the Etendue invariant, including the dynamical analogy: derivation of the skew invariant; the impossibility of designing a perfect imaging system or nonimaging concentrator with axial symmetry; the Luneburg lens; the geometry of the basic compound parabolic concentrator; the Θ_1/Θ_2 concentrator; the concentrator design for skew rays; the truncated compound parabolic concentrator; and the differential equation for the 2D concentrator profile with nonplane absorber. (WHK)

23972 **Natural convection in inclined two-dimensional compound parabolic concentrators.** Abdel Khalik, S.I.; Li, H.W. (Univ. of Wisconsin, Madison). pp 23-28 of Thermal storage and heat transfer in solar energy systems. Kreith, F.; Boehm, R.; Mitchell, J.; Bannerot, R. (eds.). New York, NY; American Society of Mechanical Engineers (1978).

From ASME meeting; San Francisco, CA, USA (10 Dec 1978).

Finite-element techniques are used to determine natural convection heat transfer coefficients between absorber surfaces and cover plates of inclined two-dimensional compound parabolic concentrators (CPC). Both full and truncated CPC cavities (troughs) of different concentrations ($2 < C < 10$) with 1/3, 2/3, and full CPC heights are examined at different Rayleigh numbers ($1.0 \times 10^3 \leqq Ra \leqq 2.5 \times 10^6$) and tilt angles ($0 < \gamma < 60°$). Generalized charts and correlations for estimating the average absorber plate Nusselt number as a function of Rayleigh number, concentration, and tilt angle are given. The results are useful for evaluating the convective loss coefficients from such collectors.

23973 **Natural convection heat transfer in small and moderate aspect ratio enclosures: an application to flat plate collectors.** Meyer, B.A.; El-Wakil, M.M.; Mitchell, J.W. (Univ. of Wisconsin, Madison). pp 29-33 of Thermal storage and heat transfer in solar energy systems. Kreith, F.; Boehm, R.; Mitchell, J.; Bannerot, R. (eds.). New York, NY; American Society of Mechanical Engineers (1978).

From ASME meeting; San Francisco, CA, USA (10 Dec 1978).

Local and average heat transfer coefficients for natural convection between parallel plates of small and moderate aspect ratios have been experimentally determined using an interferometric technique. The experimental conditions are similar to those existing in solar collectors. Measurements of the heat-transfer coefficient are made over angles of inclination with respect to the horizontal ranging from 45 degrees to the vertical. The Grashof number range studied was 10^3 to 1.4 x 10^5. The aspect ratio (the ratio of plate length to plate spacing) ranged from 0.25 to 4. The results obtained in a previous investigation for aspect ratios of 9 to 36 are included to show continuity. For aspect ratios of 4 and less, the enclosure is partitioned to obtain the required aspect ratios. These conditions are similar to those for slat-type solar collectors. Slat angles, measured with respect to the plates of 45, 60, 90, and 135 degrees, were studied. The results are useful in determining the top convection loss coefficient and therefore in minimizing losses and optimizing the design of solar collectors. The results indicate that the convective losses are strong functions of the aspect ratio for aspect rations less than 4. Slat angles less than 90 degrees (i.e., oriented downward) help reduce convective losses.

HEAT STORAGE

REFER ALSO TO CITATION(S) 23896, 23956

23974 Solar greenhouse phase change storage. Schoenfelder, J.L. (Central States Energy Research Corp., Iowa City, IA). pp 79 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

This solar greenhouses has a compacted wet dirt storage bin with Na_2SO_4 x $10H_2O$ added using ABS tubing for the ductworks. (MHR)

23975 Thermal storage and heat transfer in solar energy systems. Kreith, F.; Boehm, R.; Mitchell, J.; Bannerot, R. (eds.). New York, NY; American Society of Mechanical Engineers (1978). 84p. (CONF-781202—P1).

From ASME meeting; San Francisco, CA, USA (10 Dec 1978).

Separate abstracts were prepared for nine of the eleven papers presented. Two papers were previously included in the data base. (WHK)

23976 Analysis of energy storage by phase change with an array of cylindrical tubes. Shamsundar, N.; Srinivastan, R. (Univ. of Huston, TX). pp 35-40 of Thermal storage and heat transfer in solar energy systems. Kreith, F.; Boehm, R.; Mitchell, J.; Bannerot, R. (eds.). New York, NY; American Society of Mechanical Engineers (1978).

From ASME meeting; San Francisco, CA, USA (10 Dec 1978).

An analysis of two-dimensional phase change of a salt or other phase change material (PCM) is made for the tube array in a shell and tube heat exchanger. The tubes are cooled convectively inside by a flowing fluid. The variation of total heat flux with time is calculated for several combinations of design parameters, for in-line as well as staggered tube arrangements. This information is very useful in designing PCM heat exchangers for solar and other energy storage units. The results indicate that the one-dimensional formulae that are currently in use for design have large errors, and are unable to fully account for the effect of tube arrangements. The influence of superheat in the liquid is studied, and a simplified method for ascertaining this influence is presented.

23977 Heat transfer and calorimetric studies of a direct contact-latent heat energy storage system. Costello, V.A.; Malsheimer, S.S.; Edie, D.D. (Clemson Univ., SC). pp 51-60 of Thermal storage and heat transfer in solar energy systems. Kreith, F.; Boehm, R.; Mitchell, J.; Bannerot, R. (eds.). New York, NY; American Society of Mechanical Engineers (1978).

From ASME meeting; San Francisco, CA, USA (10 Dec 1978).

Utilization of solar energy is dependent on an efficient and compact mean of storage. A possible process is to store energy in the latent heat of fusion of salt hydrates with high heats of fusion and favorable melting points. To minimize supercooling and phase segregation problems, direct contact heat transfer has been proposed. Three salt systems (calcium chloride, disodium hydrogen phosphate, and sodium sulfate) were studied as well as direct contact sensible heat storage in water. Exxon Varsol, a commercial solvent, was used as the heat transfer fluid in all experiments. Volumetric heat transfer coefficients and thermal storage efficiencies were determined at various flow rates and column heights, and with varying numbers of diffusers. In the water-Varsol system, the dependency of the volumetric coefficient on superficial velocity agreed favorably with literature results. However, the range of flow rates usable with the salt-Varsol system was not large enough to permit correlation. Average thermal storage efficiencies in a column for calcium chloride, 50% for sodium sulfate, and 74% for disodium phosphate. Based strictly on storage capacity, disodium hydrogen phosphate was the best material, storing as much as three times the energy as could be stored in an equal volume of water. However, lower unit costs for calcium chloride and sodium sulphate may make them economically competitive.

23978 Convective instability of a volumetrically heated porous bed. Somerton, C.W.; Catton, I. (Univ. of California, Los angeles). pp 71-79 of Thermal storage and heat transfer in solar energy systems. Kreith, F.; Boehm, R.; Mitchell, J.; Bannerot, R. (eds.). New York, NY; American Society of Mechanical Engineers (1978).

From ASME meeting; San Francisco, CA, USA (10 Dec 1978).

The onset of convection in a volumetrically heated porous medium saturated with fluid and overlaid with a finite layer of fluid has been determined for the case where the upper surface of the fluid layer and the lower surface of the porous bed are at the same temperature. In order to avoid a jump in the fluid velocity at the interface, the governing equations for the porous bed used Brinkman's extention of Darcy's law. Solutions are presented for a range of layer thickness ratios, fluid-to-porous bed thermal conductivity ratios, and premeabilities. The solutions compare favorably with the limiting cases of the Benard problem (where the thickness of the porous medium approaches zero) and a volumetrically heated porous bed (where the thickness of the fluid layer approaches zero).

GEOTHERMAL ENERGY

23979 (LBL—10615) **Computerized international geothermal information systems.** Phillips, S.L.; Lawrence, J.D.; Lepman, S.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 17p. (CONF-800704—1). Dep. NTIS, PC A02/MF A01.

From NATO/CCMS meeting on pilot studies; Paris, France (15 Jul 1980).

The computerized international geothermal energy information system is reviewed. The review covers establishment of the Italy - United States linked data centers by the NATO Committee on Challenges of Modern Society, through a bilateral agreement, and up to the present time. The result of the information exchange project is given as the bibliographic and numerical data available from the data centers. Recommendations for the exchange of computerized geothermal information at the international level are discussed.

RESOURCE STATUS AND ASSESSMENT

USA

REFER ALSO TO CITATION(S) 23990

23980 (DOE/RA/50076—T1) **Nevada geothermal commercialization planning. Quarterly progress report, January 1, 1980-March 31, 1980.** Pugsley, M. (Nevada Dept. of Energy, Carson City (USA)). 1980. 7p. NTIS, PC A02/MF A01.

Site specific development plans are discussed for Caliente district heating and Winnemucca ethanol production. Outreach activities are listed. (MHR)

23981 Operations research for geothermal development in California and Hawaii. Witkin, R.; Wiegand, J.; Rigby, F.; Dussman, M.; Larson, T. *Q. Bull., Geo-Heat Util. Cent.;* 4: No. 2, 5-8(Mar 1979).

The following are discussed: factors constraining geothermal development, potential markets for direct use and electric applications in California and Hawaii, scenario development for Imperial Valley, California and Puna, Hawaii and a regional progress monitor. (MHR)

NON-USA

23982 Geothermal energy development in the Soviet Union. Pryde, P.R. (San Diego State Univ., CA). *Q. Bull., Geo-Heat Util. Cent.;* 4: No. 2, 8-14(Mar 1979).

The following subjects are discussed: distribution of geothermal resources in the USSR, geothermal energy conversion to electricity, use of low-temperature fluids for space heating, use of hydrothermal resources for agriculture, and other present and prospective uses of geothermal resources. Maps are shown of geothermal gradients and areas of geothermal development in the USSR. (MHR)

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

USA

REFER ALSO TO CITATION(S) 23985

23983 (CONF-7910155—1) **Impacts of deep geothermal fluid production on shallow ground-water systems.** Moran, M.S. (Oak Ridge National Lab., TN (USA)). Nov 1979. Contract W-7405-ENG-26. 20p. Dep. NTIS, PC A02/MF A01.

From Ground water technology meeting; Oklahoma City, OK, USA (10 Oct 1979).

Geothermal energy is a nationally minor, but regionally significant, potential source of direct heat and electricity in the United States. In developing hydrothermal systems for energy production, it has been necessary in many cases to assess the potential impacts of reservoir drawdown on groundwater discharge points, such as hot springs and seeps, and gaining reaches of surface streams, because many hydrothermal and shallow groundwater reservoirs are hydraulically communicating systems. The extent of interaction between the deep hydrothermal and shallow groundwater reservoirs, however, has often been underestimated during geothermal exploration. Case studies of hydrothermal exploration and development activities at Coso Hot Springs, California, and Valles Caldera, New Mexico, have indicated that shallow groundwater systems may be affected by geothermal reservoir production. These poential impacts include reduction in quantity and temperature of natural groundwater discharge and water rights and socioreligious issues.

23984 (LA—8276-MAP) **In-progress geologic map of Canon de San Diego, Jemez Springs, New Mexico, and lithologic log of Jemez Springs geothermal well.** Goff, F.; Kron, A. (Los Alamos Scientific Lab., NM (USA)). Mar 1980. Contract W-7405-ENG-36. 30p. NTIS, PC A03/MF A01.

The map shows geologic faults, sheared rock, landslides, springs, wells, volcanic vents, and hydrothermal alteration. (MHR)

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

23985 **Mount Hood, Oregon.** Justus, D. (Geo-Heat Utilization Center, Salem, OR). *Q. Bull., Geo-Heat Util. Cent.;* **4**: No. 2, 1-4(Mar 1979).

The geology of Mt. Hood is discussed. Electrical surveys and exploratory drilling for assessment of its geothermal potential are described. (MHR)

GEOCHEMICAL TECHNIQUES AND SURVEYS

23986 (LA—8326-MS) **Geothermal investigation of spring and well waters of the Los Alamos Region, New Mexico.** Goff, F.E.; Sayer, S. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 25p. NTIS, PC A02/MF A01.

The chemical and isotopic characters of 20 springs and wells in the Los Alamos area were investigated for indications of geothermal potential. These waters were compared with known hot and mineral springs from adjacent Valles Caldera and San Ysidro. All waters in the Los Alamos area are composed of meteoric water. Isotopic data show that the two primary aquifers beneath the Los Alamos region have different recharge areas. Relatively high concentrations of lithium, arsenic, chlorine, boron, and fluorine in some of the Los Alamos wells suggest these waters may contain a small fraction of thermal/mineral water of deep origin. Thermal water probably rises up high-angle faults associated with a graben of the Rio Grande rift now buried by the Pajarito Plateau.

EXPLORATORY DRILLING AND WELL LOGGING

REFER ALSO TO CITATION(S) 24444

23987 (LA—8252-MS) **Geophysical logging case history of the Raft River geothermal system, Idaho.** Applegate, J.K.; Moens, T.A. (Los Alamos Scientific Lab., NM (USA); Boise State Univ., ID (USA)). Apr 1980. Contract W-7405-ENG-36. 34p. NTIS, PC A03/MF A01.

Drilling to evaluate the geothermal resource in the Raft River Valley began in 1974 and resulted in the discovery of a geothermal reservoir at a depth of approximately 1523 m (500 ft). Several organizations and companies have been involved in the geophysical logging program. There is no comprehensive report on the geophysical logging, nor has there been a complete interpretation. The objectives of this study are to make an integrated interpretation of the available data and compile a case history. Emphasis has been on developing a simple interpretation scheme from a minimum of data sets. The Raft River geothermal system occurs in the Raft River Valley, which is a portion of the Basin and Range geomorphic province located in south central Idaho, south of the Snake River Plain. The valley is a late Cenozoic structural downwarp bounded by faults on the west, south, and east. The downwarp is filled with Tertiary and Paleozoic sediments, metasediments, and volcanics that overlie Precambrian rocks. The variety of rock types, the presence of alteration products, and the variability of fracturing make reliable interpretations difficult. However, the cross plotting of various parameters has allowed a determination of rock types and an analysis of the degree of alteration and the density of fractures. Thus, one can determine the relevant data necessary to assess a geothermal reservoir in similar rock types and use cross plots to potentially define the producing zones.

23988 (LA-UR—80-670) **Borehole survey instrumentation development for geothermal applications.** Dennis, B.R. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 17p. (CONF-800711—1). Dep. NTIS, PC A02/MF A01.

From 21. annual logging symposium; Lafayette, LA, USA (8 Jul 1980).

The creation and subsequent study of hot dry rock geothermal reservoirs requires sophisticated tools and instruments that can function for relatively long periods of time in the hostile downhole environment. Detection of fracture dimensions and orientation of the geothermal reservoir is critical for the successful completion of the hot dry rock energy extraction system. The development of downhole instrumentation capable of characterizing the hydraulic-fracture systems must emphasize reliability of measuring devices and electromechanical components to function properly at borehole temperature exceeding 275°C and pressures of 69 MPa (10,000 psi).

LEGAL AND INSTITUTIONAL ASPECTS

23989 (CONF-800517—4) **Land use siting considerations for hydrothermal energy facilities.** Oakes, K.M. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From 26. annual technical meeting of the Institute for Environmental Sciences; Philadelphia, PA, USA (11 May 1980).

Hydrothermal resources are described and discussion is focused on some of the land use and social considerations involved in siting hydrothermal power plants. (MHR)

23990 (DOE/ID/12019—1) **Nevada geothermal commercialization planning. Semi-annual progress report, January 1, 1979-June 30, 1979.** Jackson, K.L.; Sasek, R.; Clark, N. (Nevada Dept. of Energy, Carson City (USA)). 1979. Contract FC07-79ID12019. 21p. NTIS, PC A02/MF A01.

Progress in planning and outreach activities needed for stimulation of the development and utilization of geothermal resources in Nevada is reviewed. (MHR)

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

REFER ALSO TO CITATION(S) 23989

23991 **Improvements in geothermal electric power and silica production.** Hill, J.H.; Fulk, M.M. US Patent Application 018,198. [nd]. 22p.

Electricity is generated from hot geothermal solution by extracting heat therefrom, mineral solids which form in a so cooled geothermal solution are separated to recover minerals and facilitate reinjection of the solution into the ground. The separated solids are treated to recover silica by addition of an acid (amorphous silica precipitates) or a base (other minerals precipitate and soulble silicates are formed which are subsequently precipitated by acid neutralization). If desired, after silica is separated, other minerals can be separated and recovered.

23992 **Process for purifying geothermal steam.** Li, C.T. US Patent Application 005,942. [nd]. 12p.

Steam containing hydrogen sulfide is purified and sulfur recovered by passing the steam through a reactor packed with activated carbon in the presence of a stoichiometric amount of oxygen which oxidizes the hydrogen sulfide to elemental sulfur which is adsorbed on the bed. The carbon can be recycled after the sulfur has been recovered by vacuum distillation, inert gas entrainment or solvent extraction. The process is suitable for the purification of steam from geothermal sources which may also contain other noncondensable gases.

23993 (DOE/EV—0068) **State-of-the-art hydrogen sulfide control for geothermal energy systems: 1979.** Stephens, F.B.; Hill, J.H.;

Phelps, P.L. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1980. Contract W-7405-ENG-48. 145p. Dep. NTIS, PC A07/MF A01.

Existing state-of-the-art technologies for removal of hydrogen sulfide are discussed along with a comparative assessment of their efficiencies, reliabilities and costs. Other related topics include the characteristics of vapor-dominated and liquid-dominated resources, energy conversion systems, and the sources of hydrogen sulfide emissions. It is indicated that upstream control technologies are preferred over downsteam technologies primarily because upstream removal of hydrogen sulfide inherently controls all downstream emissions including steam-stacking. Two upstream processes for vapor-dominated resources appear promising; the copper sulfate (EIC) process, and the steam converter (Coury) process combined with an off-gas abatement system such as a Stretford unit. For liquid-dominated systems that produce steam, the process where the non-condensible gases are scrubbed with spent geothermal fluid appears to be promising. An efficient downstream technology is the Stretford process for non-condensible gas removal. In this case, partitioning in the surface condenser will determine the overall abatement efficiency. Recommendations for future environmental control technology programs are included.

23994 (PB—300851) **Geothermal environmental impact assessment: subsurface environmental assessment for four geothermal systems.** Sanyal, S.; Weiss, R. (Geonomics, Inc., Berkeley, CA (USA)). Nov 1978. Contract EPA-68-03-2468. 258p. NTIS, PC A12/MF A01.

This is the second in a series of reports concerning the environmental assessments of effluent extraction, energy conversion, and waste disposal in geothermal systems. This study involves the subsurface environmental impact of the Imperial Valley and The Geysers, California; Klamath Falls, Oregon; and the Rio Grande Rift Zone, New Mexico.

23995 (UCRL—15094) **Environmental overview of geopressured-geothermal development: Texas Gulf Coast.** Gustavson, T.C.; Kreitler, C.W. (Texas Univ., Austin (USA). Bureau of Economic Geology). 1979. Contract W-7405-ENG-48. 192p. Dep. NTIS, PC A09/MF A01.

In the summary of the recommended environmental program are: site specific studies, general studies, cost estimates for the program, socioeconomic and demographic research, potential environmental concerns, environmental research, effects of geopressure exploitation, and research plans. The socioeconomic and cultural considerations are impacts on communities. Waste disposal, geologic framework, ground subsidence, and monitoring techniques are discussed. (MHR)

BY-PRODUCTS

REFER ALSO TO CITATION(S) 23991

POWER PLANT SYSTEMS AND COMPONENTS

REFER ALSO TO CITATION(S) 24014

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

REFER ALSO TO CITATION(S) 24439

23996 (DGE—4008-F) **Chemical temperature indicators for geothermal applications. Final report.** Gaven, J.V. Jr.; Bak, C.S.; Jones, V.V.; Grow, B. (Spectro-Systems, Inc., Springfield, VA (USA)). Mar 1978. Contract EG-77-C-01-4008. 30p. Dep. NTIS, PC A03/MF A01.

The objective of this program was the development of a simple, reliable method for temperaure measurement in geotherml wells duing drilling operations. The method of choice involves the use of a series of chemical temperature indicator materials, with sharply defined melting temperatures over the temperature range $80°C \leqq T \leqq 350°C$. The most promising candidate temperature indicator materials were selected for laboratory experimentation. Differential Scanning Calorimeter measurements were used to determine normal melting point, sharpness of melting point and heat of fusion of the candidate materials. As a result of these experiments, 42 alloys and 9 organic compounds were demonstrated to be acceptable temperature indicators. Since 7 organics had melting temperatures close to corresponding alloys, the useful series of temperature indicators is comprised of 44 materials. Experiments were carried out to develop a configuraion for the indicators compatible with direct addition to drilling muds. Preliminary experimentation was performed on stress resistance and hydrodynamic characteristics of the indicator configuration. The temperature indicators can be made in production quantities at an average of $1.00/each or less. Recommendations are made for testing the indicator configurations at elevated pressures in drilling fluid and for carrying out full scale field testing of the indicators under a variety of geothermal conditions.

23997 (RLO—2325) **Research and development of a high-pressure waterjet coring device for geothermal exploration and drilling. Final report, February 1976-October 1977.** Reichman, J.M. (Flow Industries, Inc., Kent, WA (USA)). Jan 1978. Contract EY-76-C-06-2325. 68p. Dep. NTIS, PC A04/MF A01.

A study was conducted to determine the feasibility of using high-pressure waterjets for coring for geothermal coring and drilling. The study examined the effects of confining pressure, borehole pressure, and temperature on jet cutting ability. Additionally, a study was made to determine the requirements of a high-pressure drilling system and the compatibility of high-pressure equipment with standard drill rigs. The study concluded that waterjet coring in geothermal formations is a feasible process and that high-pressure equipment can be made rig compatible with little modification of existing equipment.

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

REFER ALSO TO CITATION(S) 23999

DIRECT ENERGY UTILIZATION

23998 (DOE/ET/27025—T1) **Geothermal Energy Market Study on the Atlantic Coastal Plain. Geothermal Energy Market penetration: development of a model for the residential sector.** Goodman, A.C. (Johns Hopkins Univ., Baltimore, MD (USA). Center for Metropolitan Planning and Research). Sep 1979. Contract EX-76-A-36-1008. 37p. NTIS, PC A03/MF A01.

A model has been developed that examines the feasibility of using geothermal technology in heating residential structures. Specific account is taken of the small contribution of new housing to the total stock in any given year and of the durability of houses and their furnaces. Both aspects constrain the penetration of geothermal energy into the residential market. After a discussion of other market penetration paradigms, a simple model of market penetration is developed that is based on the premise that homeowners will not abandon an existing furnace until its economic life is over. Next, behavioral parameters are discussed and the model is extended from 20 to 40 years. Finally, methods are discussed for collecting the needed data to determine market penetration, and ideas are proposed of ways to induce homeowners to give up economically viable furnaces to allow the firm providing the energy to reduce costs.

23999 (LBL—10848) **Evaluation of city well 1, Klamath Falls, Oregon.** Benson, S.M.; Goranson, C.B.; Schroeder, R.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 11p. (CONF-800629—1). NTIS, PC A02/MF A01.

From Symposium on commercial uses of geothermal energy; Boise, ID, USA (16 Jun 1980).

A city-wide geothermal space heating project is currently under development at Klamath Falls, Oregon. The first phase of the project will require two production wells. Geothermally heated water will be used to heat 14 city, county, state, and federal buildings. At peak load the heating system will require approximately 750 gpm of 200°F (or greater) geothermal brine. The first production well was spudded on August 29, 1979. During drilling a major lost circulation zone was encountered between 340 and 360 ft depth. At this time the well was cleaned, reamed, cased to 300 ft, and then pump tested. The well was pumped for a total of 15 1/2 hr. A maximum flow rate of 680, with 77 ft of drawdown, was held constant for 7 1/2 hr. Discharge temperature was approximately 218°F. Three observation wells were monitored to determine the impact of producing large quantities of brine on the many private geothermal wells already in use for space heating. Preliminary indications are that the water level decline in the area will be small (2 to 3 ft). However, further testing is recommended to determine the effects of reservoir heterogeneity on the water level decline.

24000 **Potato processing.** Lienau, P.J. (Geo-Heat Utilization Center, Klamath Falls, OR). *Q. Bull., Geo-Heat Util. Cent.;* **4**: No. 2, 14-18(Mar 1979).

A study of potato processing at the Ore-Ida Foods, Inc. plant in a recent agribusiness study of the Klamath and Western Snake River Basins in Oregon is described. The application of geothermal resources to the process and the economic analysis are included. (MHR)

TIDAL POWER

WAVE ENERGY CONVERTERS

24001 (SMHI-HBF-PM—229) **Wave measuring project for wave energy prospecting purpose.** Mattisson, I. (Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping). Dec 1978. 17p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The Swedish Meteorological and Hydrological Institute (SMHI) has developed a special microcomputer programme designed for a wave measuring system capable to produce real-time wave spectra. The wave gauge being used is an inverted echo-sounder working at the frequency of 710 kHz. The wave measuring systems are located at three lighthouses where SMHI has automatic stations for collection of meteorological and oceanographical data. The echo-sounders are placed at a depth of 25 metres. The micro-computer, which is the basic unit in the automatic station, samples the wave record and computes the wave spectra and some other significant wave data. The data are transmitted to SMHI every hour by our automatic data transmission system. The wave data will be used in a study of the economic feasibility of wave power plants in Swedish coastal waters.

WIND ENERGY

24002 **Going with the wind.** Nesbit, W.; DeMeo, E.; Goodman, F. Jr. *EPRI J.*; 5: No. 2, 6-17(Mar 1980).

Interest in capturing wind power to generate electricity has increased with recent reports of progress in the areas of site selection, reliability, and flexibility, but much more research is needed to determine whether wind will be a limited or a major energy source. The fundamentals of wind energy and wind patterns are reviewed. A broad-based Federal research and demonstration program is focusing on both horizotal and vertical designs, wind characterization, and assessment for site-screening and environmental impacts. There is also a growing effort in the private sector to produce and market wind machines, but the major effort is in the National Aeronautics and Space Administration (NASA)-DOE projects. Since the electric utilities must incorporate wind systems into the power grids if wind is to have an important role, the Electric Power Research Institute (EPRI) is providing much of the liason between the utilities and the federal effort. (DCK)

ECONOMICS

24003 (SERI/TP—731-649) **Screening method for wind energy conversion systems.** McConnell, R.D. (Solar Energy Research Inst., Golden, CO (USA)). Mar 1980. Contract EG-77-C-01-4042. 6p. (CONF-800604—19). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

A screening method is presented for evaluating wind energy conversion systems (WECS) logically and consistently. It is a set of procedures supported by a data base for large conventional WECS. The procedures are flexible enough to accommodate concepts lacking cost and engineering detail, as is the case with many innovative wind energy conversion systems (IWECS). The method uses both value indicators and simplified cost estimating procedures. Value indicators are selected ratios of engineering parameters involving energy, mass, area, and power. Cost mass ratios and cost estimating relationships were determined from the conventional WECS data base to estimate or verify installation cost estimates for IWECS. These value indicators and cost estimating procedures are shown for conventional WECS. An application of the method to a tracked-vehicle airfoil concept is presented.

WIND ENERGY ENGINEERING

REFER ALSO TO CITATION(S) 23873

TURBINE DESIGN AND OPERATION

24004 (DOE/NASA/0026—79/1) **Wind energy system time-domain (WEST) analyzers using hybrid simulation techniques.** Hoffman, J.A. (Paragon Pacific, Inc., El Segundo, CA (USA)). Oct 1978. Contract EX-76-A-29-1028. 30p. (NASA-CR—159737; PPI—1030-6). Dep. NTIS, PC A03/MF A01.

A qualitative description of each element of the WEST analyzers is presented. Uses for the analyzers in examining wind energy system operation in the random wind environment are identified. The results of limited correlation efforts are presented, which show good performance of the WEST units when compared to alternative analytical methods. A description of the WEST verification procedure is also included.

24005 (DOE/NASA/0058—79/2(Vol.1)) **Mod-1 wind turbine generator analysis and design report.** (General Electric Co., Philadelphia, PA (USA). Space Div.). Mar 1979. Contract EX-76-A-29-1010. 329p. (NASA-CR—159495). NTIS, PC A15/MF A01.

Information on the Mod 1 wind turbine program is presented concerning the system description; structural dynamics; stability analysis; mechanical subassemblies design; power generation subsystem; and control and instrumentation subsystem.

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 24074, 24075, 24210, 24247, 25057, 25058, 25059

24006 (DOE/EIA/10480—T1) **Generating technology assessment. Phase I work plan, Task 1 report.** (Teknekron Research, Inc., Berkeley, CA (USA). Energy and Environmental Systems Div.). 15 Oct 1979. Contract AC01-79EI10480. 78p. Dep. NTIS, PC A05/MF A01.

A plan of work outlining information to assess electric generating technologies is presented. Projections are made of realistic and understandable engineering and cost assessments of nonnuclear electrical generating technologies. A computer-based method of producing such engineering and cost estimates for use by EIA's Coal and Electric Power Analysis Division is to be developed and implemented. Technologies and processes to be assessed are: all nonnuclear conventional and nonconventional (coal gasification, advanced combustion turbines, atmospheric fluidized bed combustion, fuel cells, geothermal, solar thermal and photovoltaics, biomass conversion to electricity, ocean thermal, wind, and MHD). Engineering specifications recommended for determination are listed. Compatibility of the technologies are to be assessed with EIA models: MEFS, LEAP, and NCM.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

24007 (EPRI-FP—1251) **Summary of equilibrium and process model data acquisition: treatment of recirculated cooling water, Resource Document 1. Interim report.** Micheletti, W.C.; Owen, M.L. (Radian Corp., Austin, TX (USA)). Dec 1979. 75p. Dep. NTIS, PC A04/MF A01.

The results of a comprehensive literature data acquisition effort focusing on all aspects of cooling water chemistry are presented. During this search, special emphasis was given to four subject areas: (1) silica species, (2) phosphate species, (3) softening operations, and (4) chemical cooling water treatments. The data documented are meant to serve three specific purposes: (1) to support development efforts for a computer program capable of describing closed loop recirculating cooling systems, (2) to support the development of an effective field test program for a portable test facility, and (3) to support the development of a laboratory test plan for determining chemical and operational data not found in the literature.

24008 (PB—299950) **Water management model for Front Range River Basins.** Labadie, J.W.; Shafer, J.M. (Colorado State Univ., Fort Collins (USA). Water Resources Research Inst.). Apr 1979. Contract DI-14-34-0001-8006. 118p. NTIS, PC A06/MF A01.

The report describes the development of a simulation model for water planning or management in a Front Range River basin or sub-basin. The application of the model is illustrated by two cases. Cooling water demands for the Rawhide Power Plant in Larimer County are proposed to be met with reusable foreign water from Fort Collins' sewer effluent. The model examines all options in reservoir storage and stream and river exchnges and selected options in reservoir storage and stream and river exchanges and elects the optimum combination. Vested water rights are alway protected. The second case in management of water releases from storage in high mountain reservoirs in such a way that vested water rights ramain undisturbed, while at the same time instream flow demands are more nearly met.

24009 (PB—301308) **Analytical method for determining seismic response of cooling towers on footing foundations. Interim report no. 1.** El-Shafee, O.; Gould, P.L. (Washington Univ., St. Louis, MO

(USA). Dept. of Civil Engineering). Sep 1979. 228p. NTIS, PC A11/MF A01.

A finite element model was developed to analyze shells of revolution under dynamic loading with soil-structure interaction effects. The model consists of high-precision rotational shell finite elements, representing the axisymmetric shell, supported on an equivalent boundary system, representing the soil medium. The substructure method is used to model the shell and soil components. In addition to the seismic analysis capability of the proposed model, it is also applicable to other dynamic loads such as wind. The dynamic behavior of a hyperboloidal cooling tower is studied using the proposed model. Dynamic properties are studied and stress analysis is carried out for a variety of soil conditions. The appendices include high precision rotational shell elements, details of stiffness matrix for an isoparametric solid element, a listing of the SUBASE Program, and modifications and additions for the User's Manual of the SHORE-III Program.

POWER CYCLES

REFER ALSO TO CITATION(S) 24018

24010 (DOE/ET/15209—T1) **Design and development of Stirling Engines for stationary power generation applications in the 500 to 3000 hp range. Subtask 1A report: state-of-the-art conceptual design.** (General Electric Co., Philadelphia, PA (USA). Valley Forge Space Center). 1 Mar 1980. Contract AC02-79ET15209. 362p. Dep. NTIS, PC A06/MF A01.

The first portion of the Conceptual Design Study of Stirling Engines for Stationary Power Application in the 500 to 3000 hp range which was aimed at state-of-the-art stationary Stirling engines for a 1985 hardware demonstration is summarized. The main goals of this effort were to obtain reliable cost data for a stationary Stirling engine capable of meeting future needs for total energy/cogeneration sysems and to establish a pragmatic and conservative base design for a first generation hardware. Starting with an extensive screening effort, 4 engine types, i.e., V-type crank engine, radial engine, swashplate engine, and rhombic drive engine, and 3 heat transport systems, i.e., heat pipe, pressurized gas heat transport loop, and direct gas fired system, were selected. After a preliminary layout cycle, the rhombic drive engine was eliminated due to intolerable maintenance difficulties on the push rod seals. V, radial and swashplate engines were taken through a detailed design/layout cycle, to establish all important design features and reliable engine weights. After comparing engine layouts and analyzing qualitative and quantitative evaluation criteria, the V-crank engine was chosen as the candidate for a 1985 hardware demonstration.

24011 (DOE/ET/15457—10) **Long Term Materials Test Program. Quarterly progress report, January-March 1980.** (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). Apr 1980. Contract AC01-79ET15457. 22p. NTIS, PC A02/MF A01.

Objective of the program is to identify corrosion-resistant materials for potential use in a gas turbine. A test rig has been devised for determining the long-term effects of coal-fueled pressurized fluidized-bed combustor exhaust gas on such materials. The test is described. (DLC)

24012 (FE—2612-16) **Advanced Coal-Fueled Combustor/Heat Exchanger Technology Study. Research and development plan.** Campbell, J.C. Jr. (Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.). Jun 1978. Contract EF-77-C-01-2612. 66p. Dep. NTIS, PC A04/MF A01.

Much of the rationale for studying the coal-fired, closed-cycle gas turbine power generation system lies in two factors. The closed-cycle gas turbine power system, which utilizes a non-condensing working fluid, is capable of higher overall thermal efficiencies than is the conventional steam-based Rankine system utilized in present day steam power stations. It utilizes higher working fluid temperatures to achieve this higher efficiency. Additionally, the utilization of the closed cycle as opposed to the open gas turbine cycle, isolates the turbomachinery from the products of coal combustion. These coal combustion products are so dirty, corrosive, and erosive that no practical system for their direct utilization in gas turbines has yet been devised, and near term achievement of practical coal fired open cycle gas turbines appears unlikely. The direct coal firing of heat exchangers, by comparison, is present day state-of-the-art at the lower working fluid temperatures typical of today's steam based power cycles. The operating requirements for the coal fired combustor/heat exchanger of a closed cycle gas turbine power conversion system differ from those of steam boilers in several respects, particularly as regards maximum heating surface temperatures. But they are sufficiently similar that the attainment of technology readiness for such combustor/heat exchangers is expected to be attainable for modest development costs and in the near future, thus permitting more efficient utilization of the only economically abundant US fuel, coal. The effort contracted for consisted entirely of studies, analyses, design effort and reporting. No fabrication or test effort was involved.

24013 **How much can we rely on a combined-cycle plant.** Whitaker, R. *EPRI J.;* 5: No. 2, 22-27(Mar 1980).

New findings should relieve some of the uncertainties about the reliability characteristics and control of combined-cycle power plants using combustion turbines. The new analyses conclude that combined-cycle is practical and that designs can be modified to use coal-derived fuels. Reliability questions had developed from the experiences of peaking units which experienced frequent forced outages. The Electric Power Research Institute and others analyzed the operating records of these units to characterize six factors of the failures: duty cycle, automated operation immaturity, dependency, repair urgency, and spare parts. Their findings are forming the basis for research and development programs aimed at design changes which will improve reliability. (DCK)

24014 **Air pressure differential energy system.** Wood, P.J. US Patent 4,106,295. 15 Aug 1978. Filed date 14 Mar 1977. 6p.

An air pressure differential energy generation system comprising a stack for conduction of air from a high to a low atmospheric pressure level is described. A vapor injection device within the stack provides a method of filling the stack at least in part with water vapor. A heat exchanger is provided at the high atmospheric pressure end of the stack. A turbine is coupled to the heat exchanger and is impelled by warmed air. An electrical generator is coupled to the turbine to provide electrical power. 7 claims.

COMPONENTS

REFER ALSO TO CITATION(S) 24010

24015 (DOE/ET/15457—4) **Long-Term Materials Test Program. Quarterly progress report, October-December 1979.** (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). Jan 1980. Contract AC01-79ET15457. 11p. NTIS, PC A02/MF A01.

Materials are to be tested for protection of gas turbines from corrosion caused by alkali in the efflux from a pressurized fluidized-bed combustor. The test facility and test sections are described. (DLC)

24016 (EPRI-NP—1186) **Steam injected gas turbine study: an economic and thermodynamic appraisal. Final report.** Brown, D.H. (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). Sep 1979. 62p. Dep. NTIS, PC A04/MF A01.

A steam-injected gas turbine was compared to the simple cycle gas turbine and to a combined-cycle gas turbine on the basis of efficiency, specific work, and economics in producing electricity. The selected operating ratio of steam to air-flow was appropriate for both peak efficiency and for limitation of a visible white exhaust plume. More complex steam injection gas turbine cycles were not justified by superior economics or performance. The economic comparisons showed potential advantage for the steam-injected gas turbine at virtually all electric utility capacity factors for use as compared to the simple-cycle gas turbine. The steam-injected gas turbine shows the possibility of a cost of electricity comparable to combined cycles at higher capacity factors.

24017 (FE—1765-44) **High temperature gas turbine engine component materials testing program: Task I. Fireside I. Final report.** (General Electric Co., Schenectady, NY (USA). Gas Turbine Div.). 1 Jul 1978. Contract EX-76-C-01-1765. 286p. NTIS, PC A13/MF A01.

This program was designed to evaluate the effect of the combustion products of coal-derived fuels on current and potential materials used in gas turbine hot-section components and on the plugging of cooling holes in air-cooled airfoils. Atmospheric-pressure small burner rigs and turbine simulators, each of which consisted of a combustor operating at elevated pressures and design air flows equipped with a segment of a first-stage nozzle, were used in these evaluations. Alkali conversion tests were conducted in small burner rigs and in the turbine simulator to determine whether alkali metals in minerals (silicates, alumino-silicates, etc.) convert to corrosive water-soluble forms (sulfates) during combustion. It was found that sufficient alkali is released from the silicate host to produce aggressive deposits of Na_2SO_4 and K_2SO_4, and that more Na than K is released. Screening tests were conducted in small burner rigs to determine the corrosive effects of the alkali contaminants Na and K expected in coal-derived liquids. The twenty-one materials tested in order of decreasing resistance to hot corrosion at 1600°F were ceramics, coatings and claddings, and Co- and Ni-base alloys. Potassium, in combination with Na, is more aggressive than Na alone, and corrosion increased with increasing potassium in deposits. Relative corrosion resistance ranking of materials against Na alone, however, is the same as in tests with Na and K combined. Parts life estimates

were determined for representative Ni- and Co-base alloys, the Co-base coatings and claddings, and the cladding FeCrAlY. The estimates were for several metal penetrations, fuel contaminant levels of 2 ppM Na and 1 ppM K to 10 ppM Na and 20 ppM K, pressures of 5 atm to 15 atm and temperatures of 1400 to 1800°F.

24018 (FE—1806-86) **Development of high-temperature turbine subsystem technology to a technology readiness status, Phase II. Quarterly report, January-March 1980.** (General Electric Co., Schenectady, NY (USA). Gas Turbine Div.). May 1980. Contract EX-76-C-01-1806. 77p. NTIS, PC A05/MF A01.

Progress in the development of a coal-derived low-Btu gas-fueled high-temperature, 2600 to 3000°F firing temperature, gas turbine for use in a combined-cycle power plant is reported. Information is included on component design and testing, materials testing, and evaluation of the commercial viability of the gas turbine system. (LCL)

24019 (FE—2786-38) **Ceramics Technology Readiness Development Program. Phase I: conceptual designs and material screening. Final report.** (Westinghouse Electric Corp., Concordville, PA (USA). Combustion Turbine Systems Div.). Nov 1979. Contract EF-77-C-01-2786. 480p. NTIS, PC A21/MF A01.

The Westinghouse Phase I, Conceptual Designs and Material Screening Program, met the program objectives wherein: feasibility of the application of structural ceramics and thermal barriers to hot section components was established; substantial benefits (efficiency, emissions control, etc.) using ceramics in engine hot sections were reconfirmed and quantified; key development issues were established for an effective development program; and an effective, economical, comprehensive and flexible follow-on CTRD program plan was completed. The benefits that can be derived in applying structural ceramics in large utility engines using the Westinghouse approach are: the highest combined cycle plant efficiency of any known system incorporating combustion turbines; application of ceramics in hot wall combustion systems will be required to meet emissions (particularly NO/sub x/) regulation requirements with a variety of fuels; coal-derived fuels can be used without causing excessive corrosion/erosion problems; and hot section component life will be increased without compromising reliability.

24020 **Solid fuel fired gas turbine system having continuously regenerating granular filter.** Smith, R.D. US Patent 4,033,117. 5 Jul 1977. Filed date 8 Jan 1976. 8p.

A solid fuel fired gas turbine system is described for generating electric power. The system includes a generator, a turbine for operating the generator, a combustion chamber for turning solid fuel to form heated gas under pressure for operating the turbine, and a continuously regenerating granular fiber for removing particulate matter from the pressurized, heated gas. The granular filter is operable at high temperature and pressure and is particularly well suited for continuously cleaning the pressurized, hot gas used to operate the gas turbine without significant loss of gas pressure or temperature.

24021 **Granular filter.** Lear, D.E. Jr; Schmid, A.H.; Wigton, H.F.H. US Patent 4,035,170. 12 Jul 1977. Filed date 8 Jan 1976. 8p.

The invention described and claimed in this application relates to granular filters and, more particularly, to continuously regenerate granular filters operatable at high temperature and pressure which are particularly suited for cleaning gas used to operate a gas turbine. The filter is of relatively small size and by nature of its operation couples high filtering efficiency with maximum practicable protection to downstream equipment from ash from combustion of the solid fuel and from small particle of the filtering medium entrained in the flowing gas, which would case deposit buildup and erosion to the turbine blades.

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 24310

ECONOMICS

REFER ALSO TO CITATION(S) 23850

OFF-PEAK ENERGY STORAGE

REFER ALSO TO CITATION(S) 24155

FUELS

REFER ALSO TO CITATION(S) 23439, 23561

24022 (COO—4433-3) **Theoretical studies on heterogeneous combustion. Progress report, March 1, 1979-February 29, 1980.** Law, C.K. (Northwestern Univ., Evanston, IL (USA). Dept. of Mechanical and Nuclear Engineering). 1980. Contract EG-77-S-02-4433. 16p. Dep. NTIS, PC A02/MF A01.

Progress is reported on theoretical studies of the ignition and combustion of liquid fuels for power plants. Information is included on fuel accumulation effects in droplet burning; ignition criterion for spray droplets; vaporization and ignition of fuel spray jets; and combustion of cool-oil-mixture drops. (LCL)

24023 (FE—3162-T1) **Evaluation of coal/oil/water slurry (COWS) emulsions produced by an on-line cavitation emulsification process.** Taylor, D.; Parker, J.; Weinreich, B. (Daedalean Associates, Inc., Woodbine, MD (USA)). Oct 1979. Contract ET-78-C-01-3162. 112p. Dep. NTIS, PC A06/MF A01.

The major objective of this research effort was to evaluate the feasibility of producing a stable Coal/Oil/Water Slurry (COWS) emulsion utilizing cavitating emulsification technology. In order to meet this objective, the research program concentrated on the following areas of investigation: (1) The operational parameters of velocity, pressure, orifice size, intensity of cavitation, water droplet size, and percentage water added in order to produce a stable COWS emulsion were determined. (2) The experiments necessary to establish the emulsification parameters with respect to system power requirements were performed. (3) The research effort was limited to a 30 percent by weight coal emulsion. In addition to the original areas of concentration, the particle size distribution of the coal within the emulsion was also evaluated. While evaluating the distribution, an attempt was made to establish the size reduction of the coal particle as a result of exposure to the cavitating slurry. The data generated from the test results for evaluating these parameters can be used as design criteria or a prototype COWS emulsifier. COWS emulsions of 10 and 20 percent water were evaluated for particle size reduction.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 23532, 23550, 23798, 23847, 23849, 24628, 24767

24024 (CONF-800543—2) **Best approach to impact assessment is to use empirically based or simulation models to forecast impacts. Environmental Sciences Division Publication No. 1538.** Christensen, S.W. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 25p. NTIS, PC A02/MF A01.

From 5. national workshop on entrainment and impingement; San Francisco, CA, USA (5 May 1980).

This paper advocates the utility of mathematical models, as contrasted with statistical procedures and processional judgment, for assessing environmental impacts. While it would be desirable to use statistical tests to detect and estimate impacts, this is generally difficult or impossible to do, even with existing sources of impact. Empirical modeling, supported by statistical analyses when possible, is proffered as the logical alternative. Next, for purposes of forecasting impacts, the use of models as opposed to professional judgment or experience is considered. The conclusion is reached that, while models cannot answer all of the relevant questions, they can be used effectively and can address problems that are beyond the reach of statistical methods.

24025 (CONF-800543—3) **Population-level assessments should be emphasized over community/ecosystem-level assessments. Environmental Sciences Division Publication No. 1535.** Van Winkle, W. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 12p. NTIS, PC A02/MF A01.

From 5. national workshop on entrainment and impingement; San Francisco, CA, USA (5 May 1980).

Arguments are presented in favor of emphasizing population-level assessments over community/ecosystem-level assessments. The two approaches are compared on each of four issues: (1) the nature of entrainment/impingement impacts; (2) the ability to forecast reliably for a single fish population as contrasted to the ability to forecast for an aquatic community or ecosystem; (3) practical considerations involving money, manpower, time, and the need to make decisions; and (4) the nature of societal and economic concerns. The conclusion on each of these four issues is that population-level assessments provide the optimal approach for evaluating the effects of entrainment and impingement mortality.

24026 (CONF-800543—4) **Impact of impingement on the Hudson River white perch population.** Barnthouse, L.W.; Van Winkle, W. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 19p. NTIS, PC A02/MF A01.

From 5. national workshop on entrainment and impingement; San Francisco, CA, USA (5 May 1980).

Portions of document are illegible.

The impact of power plant impingement on the 1974 and 1975 year classes of the Hudson River white perch population is assessed using a simple model derived from Ricker's theory of fisheries

dynamics. The impact of impingement is expressed in the model as the conditional mortality rate, rather than as the more commonly used exploitation rate. Since the calculated impact is sensitive to errors in the estimation of population size and total mortality, ranges of probable values of these quantities are used to compute upper and lower bounds on the fractional reduction in abundance of each year class. Best estimates of abundance and mortality are used to compute the conditional impingement mortality rate separately for each plant and month. The results are used to assess the relative impacts of white perch impingement at six Hudson River power plants and to identify the seasons during which the impact is highest.

24027 (DOE/RA/10001—T1) **Analysis of environmental factors affecting technology deployment: a case study.** Meyers, C.D.; Pechan, E.H. (Department of Energy, Washington, DC (USA). Office of Resource Applications). 1979. 69p. Dep. NTIS, PC A04/MF A01.

A study was conducted for the Office of Resource Applications, US Department of Energy (DOE), to assess the potential market and possible market penetration of four electric baseload generating technologies employing coal combustion, in three selected geographic areas of the US, within the time frame between the present and the year 1998. The major focus was on quantification of environmental performance of these technologies and relation of environmental performance to environmental constraints identified in the study area. The technologies under consideration were all coal-fired electric generation of the following types: conventional steam-electric generation with flue gas scrubbers for desulfurization (the baseline technology); steam-electric generation utilizing atmospheric fluidized bed combustion (AFBC); steam-electric generation utilizing pressurized fluidized bed combustion (PFBC); and electric generation utilizing combined cycle turbines (CC). Three geographic areas corresponding to utility power pools were selected for study: peninsular Florida, a southern region (most of the states of Alabama, Georgia, and Mississippi), and part of the state of Texas. A summary of findings and conclusions is presented. In Chapter 2, the analytic approach is presented; in Chapter 3, the technology specific environmental factors are presented; in Chapter 4, information on the growth in generation is presented; and in Chapter 5, the environmental implications of deployment of the new technologies is explored.

24028 (PB—300391) **The Environmental Protection Agency and the Kaiparowits Power Project: a case study of EPA's performance of its environmental review responsibilities.** Ullery, S.J. (Arizona Univ., Tucson (USA). Inst. of Government Research). May 1976. 71p. NTIS, PC A04/MF A01.

The study focuses on the description of the Environmental Protection Agency's (EPA's) review of the Bureau of Land Management's impact statement for the Kaiparowits Power Project. The Kaiparowits project, involving new coal mining operations, the construction of a coal haul railway, transmission lines to the major load centers in Arizona and Southern California, and the world's largest coal-fired electric generating plant was considered to be the most important component of Phase II in the development of electric energy production of the Four Corners region. In the examination of EPA's role vis-a-vis the project, the origin of the agency's interest in Kaiparowits is traced to the Southwest Energy Study. The agency's guidelines for review of impact statements are summarized. The Office of Federal Activities (FA), the headquarters office responsible for coordinating and overseeing the review of environmental impact statements, is considered. A discussion of how EPA's Region VIII Office performed its review responsibilities is presented. The data upon which this study is based were gathered primarily from March to May, 1976 in Washington, D. C. and Denver, Colorado.

24029 **Continuing disposal of coal ash.** Lihach, N.; Golden, D. *EPRI J.*; 5: No. 2, 18-19(Mar 1980).

The large volume of power-plant coal ash produced and stricter Federal water pollution controls are making ash disposal increasingly difficult for utilities. The protection of surface and ground water quality required in the Resource conservation and Recovery Act of 1976 (RCRA) and the Federal Water Pollution Control Act's Clean Water Act (CWA) amendments of 1977 have raised the cost of disposal to a level where an acceptable method must be found. The Electric Power Research Institute's Coal Ash Disposal Manual (EPRI-FM—1257) describes-ash chemistry, disposal site selection, site monitoring and reclamation, and other information of interest to utilities that are making cost estimates and procedure evaluations. (DCK)

24030 **Delicate disposal of PCBs.** Lihach, N.; Golden, D. *EPRI J.*; 5: No. 2, 20-21(Mar 1980).

The Electric Power Research Institute (EPRI) has published three handbooks to help utilities evaluate the alternatives for disposal of polychlorinated biphenyls (PCBs), which will continue to be a utility responsibility for some time. The identification of PCBs as a toxic substance in 1976 ended their use as a capacitor and transformer insulator, but 375 million pounds are distributed in equipment and their disposal must be carefully planned. The booklets outline Environmental Protection Agency (EPA) regulations, the disposal technology by incineration or landfill which is currently available, and guidelines for preventing spills and controlling risks. (DCK)

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 23413, 23460, 23480, 23482

24031 (EPA—600/7-79-238) **EPA/IERL-RTP pilot electrostatic precipitator: selected experiments, 1978.** VanOsdell, D.W.; Sparks, L.E.; Ramsey, G.H.; Daniel, B.E. (Environmental Protection Agency, Research Triangle Park, NC (USA). Industrial Environmental Research Lab.). Nov 1979. 62p. NTIS.

This report deals with experiments run on a pilot-scale electrostatic precipitator located at IERL-RTP. The precipitator is a dedicated experimental tool which is operated for experiments originated and designed both in-house and by EPA contractors. Five distinct test series conducted between March and October 1978 are described in this report. The areas of study were precharger operation, precipitator operating characteristics, reentrainment, parameter variation with position within precipitator, and effects of humidity. The results of the precharger test series were inconclusive; removal efficiency was 10 to 20% better with the precharger for most size ranges but its operation was erratic in this preliminary test. The reentrainment test demonstrated that sparking produced more and larger particulate than other reentrainment mechanisms. No pattern of size distribution change was established. The study of flow, mass, and particle size as a function of sample probe position showed that parameter variations do exist. The data collected was not sufficient to fully establish the differences. The study of the effects of hunidity on collection efficiency demonstrated that increased moisture had a strong impact on improved performance. The moisture lowers the particulate resistivity, allowing increased electrical fields. Efficiency correlated well with voltage in the form: $p = 6.59 \times 10^{8} V^{-5.46}$ where P = penetration, %, V = voltage, kV. The correlation coefficient, r^2, was 0.97.

24032 (EPRI-FP—1307(Vol.1)) **Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 1. Task I report: literature review, basis for selecting calcium-based sorbents. Final report.** O'Neill, E.P.; Ulerich, N.H.; Newby, R.A.; Keairns, D.L. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). Dec 1979. 78p. Dep. NTIS, PC A05/MF A01.

Prevention of sulfur dioxide emissions in atmospheric pressure fluidized-bed combustion (AFBC) of coal is accomplished by adding limestone to the bed at three times the stoichiometric ratio for calcium sulfate formation. Wide variations in the physical and chemical composition of the sorbent as mined at various sites result in the requirement for development of sorbent selection criteria to choose the best stone in any particular instance. Previous work on factors influencing the desulfurization performance of various types of limestone are reviewed and conclusions as to the effect of variations in sorbent properties summarized. The status of development of models for predicting desulfurization in AFBC is updated. Current theories on the influence of operating variables on desulfurization efficiency are reviewed. It is concluded that while structural studies have explained many features of the observed differences in desulfurization efficiency, current classifications are not adequate for the quantitative prediction of performance in fluidized beds. A program is outlined in which limestone sorbents for an AFBC development unit site should be selected from candidate stones available locally based on the results of laboratory tests on structural, reactivity, and attrition properties.

24033 (EPRI-FP—1307(Vol.2)) **Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 2. Tasks II and III report: experimental work, sorbent selection technique. Final report, November 1, 1976-July 31, 1977.** Ulerich, N.H.; O'Neill, E.P.; Alvin, M.A.; Keairns, D.L. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). Dec 1979. 125p. Dep. NTIS, PC A06/MF A01.

Five limestones were tested in the laboratory to evaluate their suitability as sulfur removal sorbents in atmospheric pressure fluidized-bed combustion. Physical characterization of the sorbents (grain size and pore-volume distribution) and chemical analyses were followed by reactivity tests in a thermogravimetric (TG) apparatus and by batch sulfation in a fluidized-bed unit. The distribution of sulfur in the sulfated products was determined by an electron microprobe. Reactivity studies covered a range of particle sizes, temperatures, and precalcination treatment. The reactivity data from TG and fluidized-bed studies were compared and found to be consistent, and the desulfurization data correlated well with the Babcock and Wilcox results on a fluid-bed coal combustor. The data were used to project the effect of operating variables (bed height, superficial velocity, and coal sulfur content) on the limestone consumption required for desulfurization. Analysis of the data does not reveal an a

priori basis for selecting sorbents, but sorbent performance can be projected after TG tests. A standard sorbent selection procedure is recommended. It is also recommended that the self-consistent body of data collected be analyzed using a currently available mathematical model of the gas/solid reaction.

24034 (FE—3242-11) **Laminar flow cyclone development program. Quarterly technical progress report, July 1, 1979-September 30, 1979.** Giles, W.B.; Bekofske, K.L. (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). Oct 1979. Contract ET-78-C-01-3242. 22p. NTIS, PC A02/MF A01.

The principal constraint to high Reynolds number operation is due to boundary layer instability in the radial inflow swirl region. Therefore, a modified model has been built and is under test with the results compared against a simplified flat plate analysis. These heated plate results, to date, suggest that the flow is transitional, in agreement with the dye injection observations. But these observations are subjective and a turbulent flow interpretation is possible. Insulating the inner portions of the heated plate will be used to increase temperature differentials.

24035 (METC/SP—79/10(Pt.1), pp 220-244) **Composition and properties of Kentucky power plant ash.** Rose, J.G.; Lowe, J.A.; Floyd, R.K. (Univ. of Kentucky, Lexington). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

Power plant ash samples were taken from the 18 coal-fired, public-service power generating plants in Kentucky, and evaluated for certain physical and chemical properties. Representative coal samples were also obtained and evaluated for comparison purposes. The ash samples varied widely reflecting the effects of type coal burned and type generating facility. Tests for particle size, fineness, specific gravity, compaction, typical coal analyses, loss of ignition, and elemental chemical composition were conducted. Presented are descriptions of PPA production and distribution in the state, the sampling process, laboratory testing procedures and test results, and projections for Kentucky PPA production and utilization in the future.

24036 (ORNL—5657) **Options for the collection and disposal of carbon dioxide.** Baes, C.F. Jr.; Beall, S.E.; Lee, D.W.; Marland, G. (Oak Ridge National Lab., TN (USA); Oak Ridge Associated Universities, Inc., TN (USA). Inst. for Energy Analysis). May 1980. Contract W-7405-ENG-26. 38 p. NTIS, PC A03/MF A01.

If society should ever decide that unacceptable changes in climate are imminent because of the accumulation of carbon dioxide in the atmosphere from the use of fossil fuels, it may be necessary to collect and dispose of carbon dioxide. At present it appears that such disposal would consume a large fraction of the energy derived from the fossil fuel. To scrub and strip carbon dioxide from the flue gas of a coal-fired power station by the most efficient method presently available would require about 43% of the combustion energy of the coal. If the coal were burned in pure oxygen to avoid scrubbing and stripping, at least 30% of the combustion energy would be required to supply the oxygen. After recovery the best option for disposal of carbon dioxide is in the deep ocean where the low rate of circulation should give a retention time of hundreds of years. Injection could be in the form of a concentrated seawater solution and at a depth sufficient to prevent bubble formation. Such a stream could be denser than seawater and form a negatively buoyant plume that might convey much of the CO_2 to the bottom. Alternatively, liquid carbon dioxide could be injected into the ocean, but at greater depths to achieve the needed density. Or blocks of solid carbon dioxide hydrate or dry ice released at the ocean surface might reach deep water quickly enough for effective disposal. The most efficient option for the future might be floating, coal-fired power plants that use cold deep seawater for both condenser cooling and carbon dioxide disposal. In particular, it might be practical simply to compress the flue gas and discharge it at a depth which would insure that the CO_2 is dissolved and carried to the deep ocean. As a near-term option, depleted oil and gas fields could be used for disposal of carbon dioxide.

24037 (PB—300515) **Effectiveness and cost of air pollution control for coal-fired electric power plants in the west.** Harrington, W.; Sawyer, J.W. Jr. (Resources for the Future, Inc., Washington, DC (USA)). Jun 1978. 50p. NTIS, PC A03/MF A01.

Estimates of air pollutant emission at four different coal-fired steam plants using fuels of various qualities, for three different levels of control technology, are reported. This study was designed especially to assess the impact of a particular plant in a particular location on ambient air quality. The locations of the plants are the Four Corners Area, Capitol Reef, Yampa River Basin, and Northern Montana. The assumed coal quality with respect to ash, Btu/lb, and sulfur content is tabulated. Level I technology corresponds to the existing New Source Performance Standards for coal-fired boilers. Compliance is required only during periods of normal operation. Level II is EPA's recently proposed amendments to the New Performance Standards. These standards exempt compliance during periods of startup and shutdown but do not permit violations of sulfur dioxide and nitrogen oxides standards due to malfunction. Level III was the most stringent level of control examined, having been achieved only by model or demonstration plants. It assumes that standards will be met at all times. Estimated emissions for each of the control levels at each location are tabulated. Attempts were made to distinquish between normal emissions and startup. Emission rates for sulfur dioxide and nitrogen oxides are given. Estimates of costs increase proceeding from Level I to Level III.

24038 (PB—300596) **Impact of ammonia utilization by NOx flue gas treatment processes. Final report August 1977-November 1978.** Burnett, T.A.; Faucett, H.L. (National Fertilizer Development Center, Muscle Shoals, AL (USA)). Jan 1979. 133p. NTIS, PC A07/MF A01.

The report gives results of a study of the impact of ammonia (NH_3) utilization by NOx flue gas treatment (FGT) processes. The most technolologically advanced FGT system for the highly efficient (about 90%) removal of NOx from power plant stack gas is selective catalytic reduction (SCR) using NH_3. A major economic consideration in the widespread application of SCR is the impact of this demand on the domestic NH_3 market. Annual NH_3 requirements for NOx FGT control of new, fossil-fuel-fired boilers were calculated and predicted for the period 1978 to 2000. The total NH_3 supply was also projected for the same period and compared with the projected annual demand for NOx FGT. The study concludes that NH_3 demand for NOx FGT systems will begin gradually and rise at relatively slow rates, giving the domestic NH_3 market adequate time to adjust to the increased demand. Under other than study assumptions (e.g., requiring retrofit of NOx FGT systems on all large boilers), significant impacts and market disruptions are foreseen. The current and projected NH_3 production techniques were outlined and the 1978 unit production cost for NH_3 was estimated for four potential feedstocks.

SITE SELECTION AND LAND USE

REFER ALSO TO CITATION(S) 24642

POWER TRANSMISSION AND DISTRIBUTION

24039 (HNEI—7902) **Study of the feasibility of linking the islands of Maui, Molokai, and Lanai with submarine electrical power cables.** Hwang, H.H.; Young, B. (Hawaii Univ., Manoa (USA). Hawaii Natural Energy Inst.). Jan 1979. 62p. Hawaii Natural Energy Institute, Manoa.

The feasibility of linking the islands of Maui, Molokai, and Lanai with submarine electrical cables was studied. A summary of the background leading to this study, the reasons for the proposed system, the objectives of this study, the methods used, and the findings obtained to date are outlined. The requirements for linking the islands are discussed. Information regarding the submarine power cables recommended for the proposed installation; possible causes of electrical submarine transmission system failures (electrical faults, physical damage, corrosion of cables); general criteria used for the selection of submarine cable routes; and estimations of cost and time requirements for the proposed installation are covered.

24040 (PB—301367) **The effects of primary power transmission lines on the performance of LORAN-C receivers in experimental terrestrial applications. Final report May-July 1979.** Mauro, P.G.; Gakis, J.D. (Department of Transportation, Cambridge, MA (USA). Transportation Systems Center). Jul 1979. 171p. NTIS, PC A08/MF A01.

Tests were conducted to measure the effect generated by high-voltage transmission lines with and without supervisory carrier signals on the performance of typical LORAN-C receivers which might be used for land vehicle applications of the LORAN-C Navigation System. The tests were performed on four high voltage transmission line configurations owned and operated by the Tennessee Valley Authority. Transmission lines were tested with 60Hz power impressed and absent and carrier signals impressed and absent. Data are plotted for three secondary time differences measured using the East Coast LORAN-C chain. Carolina Beach was the master and Nantucket, Mass., Jupiter, Florida, and Dana, Indiana were the secondaries. Signal to noise ratios for the secondaries as well as the mster were also measured and recorded. The test area chosen had extremely good LORAN-C signal coverage. In general, with the carrier of and line de-energized, acceptable receiver performance was obtained to within approximately plus or minus 100 meters from the center of the line. With the line energized, useable performance degrades to a point about plus or minus 200 meters and with asynchronous carrier signals performance is unreliable at distances less than plus or minus 300 meters. With synchronous interference the receivers would not operate properly at 1000 meters either side of the line.

DC SYSTEMS

REFER ALSO TO CITATION(S) 24041

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

24041 (LA—8323-PR) **dc Superconducting Power Transmission Line project at LASL: US DOE Division of Electric Energy Systems. Progress report No. 24, November 1, 1972-September 30, 1979. Final report.** Edeskuty, F.J. (comp.). (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 270p. NTIS, PC A12/MF A01.

Plans for a large-scale dc SPTL test have been indefinitely postponed because of budgetary restrictions. This final report on the Los Alamos Scientific Laboratory (LASL) dc Superconducting Power Transmission Line (SPTL) Development Project covers activities in electrical engineering, cryogenic engineering, and superconductor design for the period of November 1, 1972 through September 30, 1979.

NUCLEAR POWER PLANTS

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 24082, 24084, 24088, 24095, 24097, 24533

24042 (ALO—75) **Pilot program to identify valve failures which impact the safety and operation of light water nuclear power plants.** Tsacoyeanes, J.C.; Raju, P.P. (Teledyne Engineering Services, Waltham, MA (USA)). Apr 1980. Contract EY-76-C-04-0789. 55p. (TR—3459-1). Dep. NTIS, PC A04/MF A01.

The pilot program described has been initiated under the Department of Energy Light Water Reactor Safety Research and Development Program and has the following specific objectives: to identify the principal types and causes of failures in valves, valve operators and their controls and associated hardware, which lead to, or could lead to plant trip; and to suggest possible remedies for the prevention of these failures and recommend future research and development programs which could lead to minimizing these valve failures or mitigating their effect on plant operation. The data surveyed cover incidents reported over the six-year period, beginning 1973 through the end of 1978. Three sources of information on valve failures have been consulted: failure data centers, participating organizations in the nuclear power industry, and technical documents.

24043 (EPRI-NP—1313) **Acoustic monitoring of relief valve position.** Hartman, W.F. (Technology for Energy Corp., Knoxville, TN (USA)). Feb 1980. 52p. Dep. NTIS, PC A04/MF A01.

A series of tests to establish the feasibility of monitoring relief valve positions using acoustic sensors is described. The sensors respond to noise generated when steam flows through the valve. Six types of safety and relief valves commonly used in light water reactor plants were instrumented and actuated under simulated plant conditions. In addition, background noise was measured in both pressurized water reactor plant and a boiling water reactor plant so that relative signal levels (valve open versus valve shut) could be determined. Results show that acoustic levels with the relief valves open are from one hundred to one thousand times greater than the levels with the valves shut, depending upon the valve type. Data are presented that will help system designers predict the acoustic levels that will be encountered when a relief valve opens.

24044 (SAND—80-0670) **Technical report on LWR design decision methodology. Phase I.** (Energy, Inc., Seattle, WA (USA)). Mar 1980. Contract EY-76-C-04-0789. 50p. (ALO—65). Dep. NTIS, PC A03/MF A01.

Energy Incorporated (EI) was selected by Sandia Laboratories to develop and test on LWR design decision methodology. Contract Number 42-4229 provided funding for Phase I of this work. This technical report on LWR design decision methodology documents the activities performed under that contract. Phase I was a short-term effort to thoroughly review the curret LWR design decision process to assure complete understanding of current practices and to establish a well defined interface for development of initial quantitative design guidelines.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 23847, 24042, 24043, 24044, 24082, 24083, 24084, 24085, 24087, 24088, 24094, 24095, 24097, 24533

24045 (CONF-791118—11) **Determination of K-factors for arbitrarily shaped flaws at pressure vessel nozzle corners.** Bryson, J.W. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 20p. NTIS, PC A02/MF A01.

From 7. water reactor safety research information meeting; Gaithersburg, MD, USA (5 Nov 1979).

Photoelastic and finite element studies are being conducted to determine Mode I stress intensity factor distributions along arbitrarily shaped flaw fronts at pressure vessel nozzle corners. Comparisons of results from NOZ-FLAW, BIGIF, and the photoelastic studies showed that (1) good agreement was obtained between NOZ-FLAW and the photoelastically determined K_I's for the deep flaw in an ITV model, (2) good agreement was obtained between NOZ-FLAW BIGIF for shallow and moderately deep flaws in a BWR model, and (3) less satisfactory agreement was obtained between NOZ- FLAW and the photoelastic results for the BWR models, particularly for moderately deep to deep flaws. Attempts are presently being made at understanding and explaining the discrepancies between the two.

24046 (COO—4325-02) **PWR steam generator chemical cleaning. Phase II. Final report.** (Consolidated Edison Co. of New York, Inc., New York (USA)). Jan 1980. Contract EN-77-C-02-4325. 127p. Dep. NTIS, PC A07/MF A01.

Two techniques believed capable of chemically dissolving the corrosion products in the annuli between tubes and support plates were developed in laboratory work in Phase I of this project and were pilot tested in Indian Point Unit No. 1 steam generators. In Phase II, one of the techniques was shown to be inadequate on an actual sample taken from an Indian Point Unit No. 2 steam generator. The other technique was modified slightly, and it was demonstrated that the tube/support plate annulus could be chemically cleaned effectively.

24047 (LA—8041-MS(Rev)) **TMI-2 decay power: LASL fission-product and actinide decay power calculations for the President's commission on the accident at Three Mile Island.** England, T.R.; Wilson, W.B. (Los Alamos Scientific Lab., NM (USA)). Mar 1980. Contract W-7405-ENG-36. 228p. Dep. NTIS, PC A11/MF A01.

Fission-product and actinide decay heating, gas content, curies, and detailed contributions of the most important nuclide contributors were supplied in a series of letters following requests from the Presidential Commission on the Accident at Three Mile Island. In addition, similar data assuming different irradiation (power) histories were requested for purposes of comparison. This report consolidates the tabular and graphical data supplied and explains its basis.

24048 (UCRL—52902) **Unique rod lens/video system designed to observe flow conditions in emergency core coolant loops of pressurized water reactors.** Carter, G.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Dec 1979. Contract W-7405-ENG-48. 31p. NTIS, PC A03/MF A01.

Techniques and equipment are described which are used for video recordings of the single- and two-phase fluid flow tests conducted with the PKL Spool Piece Measurement System designed by Lawrence Livermore Laboratory and EG and G Inc. The instrumented spool piece provides valuable information on what would happen in pressurized water reactor emergency coolant loops should an accident or rupture result in loss of fluid. The complete closed-circuit television video system, including rod lens, light supply, and associated spool mounting fixtures, is discussed in detail. Photographic examples of test flows taken during actual spool piece system operation are shown.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

24049 (COO—2975-40) **Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, October 1, 1979-December 31, 1979.** (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). 18 Apr 1980. Contract EY-76-C-02-2975. 55p. NTIS, PC A04/MF A01.

This report presents the results of work performed from October 1, 1979 through December 31, 1979. Work covered in this report includes the activities associated with the status of the simulated reactor helium supply system, testing equipment and gas chemistry analysis instrumentation and equipment. The progress in the

screening test program is described. This includes: screening creep results, weight gain and post-exposure mechanical properties for materials thermally exposed at 750° and 850°C (1382° and 1562°F). In addition, the status of the data management system is described.

24050 (ORNL/TM—7209) **Dependence of silicon carbide coating properties on deposition parameters: preliminary report.** Lauf, R.J.; Braski, D.N. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 40p. NTIS, PC A03/MF A01.

Fuel particles for the High-Temperature Gas-Cooled Reactor (HTGR) contain a layer of pyrolytic silicon carbide, which acts as a pressure vessel and provides containment of metallic fission products. The silicon carbide (SiC) is deposited by the thermal decomposition of methyltrichlorosilane (CH_3SiCl_3 or MTS) in an excess of hydrogen. The purpose of the current study is to determine how the deposition variables affect the structure and properties of the SiC layer.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 23672, 24086, 24089, 24090, 24091, 24093, 24096, 24423

24051 (ANL—79-57) **Development of a methodology for analysis of delayed-neutron signals.** Gross, K.C.; Strain, R.V.; Fryer, R.M. (Argonne National Lab., IL (USA)). Feb 1980. Contract W-31-109-ENG-38. 84p. NTIS, PC A05/MF A01.

Experimental and analytical techniques have been developed for analysis and characterization of delayed-neutron (DN) signals that can provide diagnostic information to augment data from cover-gas analyses in the detection and identification of breached elements in an LMFBR. Eleven flow-reduction tests have been run in EBR-II to provide base data support for predicting DN signal characteristics during exposed-fuel operation. Results from the tests demonstrate the feasibility and practicability of response-analysis techniques for determining (a) the transit time, T/sub tr/, for DN emitters traveling from the core to the detector and (b) the isotropic holdup time, T/sub h/, of DN precursors in the fuel element.

24052 (ANL—80-31) **Accurate numerical solutions for elastic-plastic models.** Schreyer, H.L.; Kulak, R.F.; Kramer, J.M. (Argonne National Lab., IL (USA)). Mar 1980. Contract W-31-109-ENG-38. 26p. NTIS, PC A03/MF A01.

The accuracy of two integration algorithms is studied for the common engineering condition of a von Mises, isotropic hardening model under plane stress. Errors in stress predictions for given total strain increments are expressed with contour plots of two parameters: an angle in the pi plane and the difference between the exact and computed yield-surface radii. The two methods are the tangent-predictor/radial-return approach and the elastic-predictor/radial-corrector algorithm originally developed by Mendelson. The accuracy of a combined tangent-predictor/radial-corrector algorithm is also investigated.

24053 (CONF-791205—23) **Heat-transfer in a partially-blocked sodium-cooled rod bundle.** Han, J.T. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 6p. NTIS, PC A02/MF A01.

From ASME winter annual meeting; New York, NY, USA (2 Dec 1979).

Heat transfer coefficients were experimentally determined for 31-rod sodium-cooled bundle with a 6-subchannel central blockage. The Nusselt number is presented as a function of the Peclet number for both the free flow region undisturbed by the blockage and the wake region immediately downstream of the blockage. Results are compared with the existing correlations for liquid metals. The heat transfer coefficient was generally higher in the unblocked free flow region than in the wake region. A leak at the blockage improved the heat transfer coefficient in the wake region.

24054 (CONF-800607—33) **Final design analyses of CRBRP fuel rod.** Bishop, B.A.; Vijuk, R.M. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). 1980. Contract AC15-76CL02395;EY-76-C-15-0003. 6p. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

The key results are presented of the CRBRP fuel rod analyses performed in support of the CRBRP fuel assembly final design review in December, 1977. For the CRBRP fuel rod design environment, it is shown that the life limiting criteria on ductility limited strain (DLS) and cumulative damage function (CDF) are satisfied. The conservatism in these analyses is demonstrated by comparison to the upset enthalpy based failure potential criteria derived from cladding breach experience for TREAT simulated unterminated rapid reactivity insertion transients.

24055 (CRBRP-GEFR-SP—176) **Clinch River Breeder Reactor Plant steam generator: FEW tube test model post test examination.** Impellezzeri, J.R.; Camaret, T.L. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). 13 Sep 1979. Contract EY-76-C-03-0189-061. 8p. (CONF-800401—10). NTIS, PC A02/MF A01.

From 2. international conference of liquid metal technology for energy systems; Richland, WA, USA (20 Apr 1980).

The Steam Generator Few Tube Test (FTT) is part of an extensive testing program being carried out in support of the Clinch River Breeder Reactor Plant (CRBRP) steam generator design. The testing of full-length seven-tube evaporator and three-tube superheater models of the CRBRP design was conducted to provide steady-state thermal/hydraulic performance data to full power per tube and to verify the absence of multi-year endurance problems. The problems encountered with the mechanical features of the FTT model design which led to premature test termination and the results of the post-test examination are described.

24056 (GEFR-SP—196) **Progress of LMFBR steam generator testing in the US.** Tippets, F.E.; Ford, J.A.; Wright, E.A.; Buschman, H.W. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). 1980. Contract FY-76-C-03-0893-010. 24p. (CONF-800401—13). NTIS, PC A02/MF A01.

From 2. international conference of liquid metal technology for energy systems; Richland, WA, USA (20 Apr 1980).

In order to improve assurancy of reliable performance, a concerted program of steam generator testing has been underway in the US since the early 1970's, performing both work oriented to the Clinch River Breeder Reactor Plant and work applicable to future plant steam generators. The approach in this program comprises a combination of small-scale and large-scale tests, special feature tests and integral proof tests, and materials tests. This paper describes the overall US program, summarizes some of the main results obtained, and outlines the efforts underway for succeeding phases.

24057 (LA-UR—80-1159) **Deep penetration calculations.** Thompson, W.L.; Deutsch, O.L.; Booth, T.E. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 29p. (CONF-800471—1). NTIS, PC A03/MF A01.

From Seminar on theory and applications of Monte Carlo methods; Oak Ridge, TN, USA (Apr 1980).

Several Monte Carlo techniques are compared in the transport of neutrons of different source energies through two different deep-penetration problems each with two parts. The first problem involves transmission through a 200-cm concrete slab. The second problem is a 90° bent pipe jacketed by concrete. In one case the pipe is void, and in the other it is filled with liquid sodium. Calculations are made with two different Los Alamos Monte Carlo codes: the continuous-energy code MCNP and the multigroup code MCMG.

24058 (LA-UR—80-1283) **Thermal conductivities of mixed carbide fuel and blanket materials.** Lewis, H.D. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 13p. (CONF-800532—1). NTIS, PC A02/MF A01.

From Core components working group information meeting; Richland, WA, USA (13 May 1980).

Measurement of the thermal and electrical transport properties of the uranium-plutonium carbides began in 1950, the bulk of the experimental work being performed in the US, UK, and France. During 1974 and 1975, as part of the national LMFBR program effort to provide unified design parameters, a series of critical reviews on the thermodynamic, physical, chemical, and mechanical properties of uranium-plutonium carbide (and nitride) fuels was prepared by authors at several US laboratories. Property values recommended by these reviews were compiled in ANL-AFP-27. The LASL review on the transport properties of uranium and plutonium carbides recommended the conductivity values that are presented.

24059 (ORNL/TM—7246) **Analysis of the initial shielding design for the upflow gas-cooled fast reactor (GCFR).** Slater, C.O.; Tomlinson, E.T.; Williams, L.R. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 67p. NTIS, PC A04/MF A01.

Presented are the results of a preliminary analysis of the initial shield design for a gas-cooled fast reactor in which the coolant flow has been reversed from downward to upward. Calculations were performed on two levels: (1) localized, heterogeneous cell calculations to determine the effects of radiation streaming, and (2) streaming-corrected full-model homogeneous calculations to obtain global radiation levels. The method used to obtain and apply the streaming factors is explained. The results indicate that with few exceptions the shielding design is very effective. Possible problems exist in (1) the core barrel, where the total neutron fluence limit of $10^{21}cm^{-2}$ is exceeded, and (2) the grid plate, where the neutron fluence is near the fluence limit predicted by damage function analysis.

24060 (PNL-TR—398) **Study of the operational characteristics of the core and irradiated fuel parameters in the BOR-60 reactor.** Gryazev, V.M.; Afanasiev, V.A.; Gadzhiev, G.I.; Efimov, V.N.; Inchagov, A.V.; Markin, S.A.; Nigmatullin, N.P.; Teikovtsev, A.A. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 14 Apr 1980. Translation of IAEA-SM—225/67. 14p. NTIS, PC A02/MF A01.

In order to determine the operational lifetimes of various fuels in terms of charge, temperature conditions, burn-up and integrated neutron flux, an extensive irradiation program for various types of fuel compositions and structural materials was carried out on the BOR-60 reactor. Ninety-percent enriched uranium dioxide in the form of sintered toroids with 10.2 g/cm^3 density was used as the standard fuel. The claddings of 37 fuel elements 6 mm in diameter are made of 0X16H15M3B austenite class stainless steel. In all, 225 such assemblies (~ 8300 fuel elements) were irradiated, including 194 assemblies with burn-up of over 8% heavy atoms. Maximum burn-up was 13.2% heavy atoms, neutron flux was 9.1 x 10^{22} neutrons/cm^2 (E > 0.1 MeV), linear power attained 540 W/cm, and cladding temperature reached 700°C.

24061 (PNL-TR—393) **Use of demonstration fast reactor experience in assessing the radiation safety of fast power reactors in the design stage.** Bakumenko, O.D.; Kiselev, G.V.; Kulakovskii, M.Ya.; Pomerantsev, G.B.; Samarkin, A.A.; Sergeev, V.A.; Skorikov, N.V.; Tverdovskii, N.D.; Tsurukin, Yu.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 4 Apr 1980. Translation of IAEA-SM—225/65, 1978. (CONF-780407—11). 10p. NTIS, PC A02/MF A01.

From Symposium on design, construction and operating experience of demonstration liquid metal fast breeder reactors; Bologna, Italy (10 Apr 1978).

The results are presented of experimental studies on the behavior of fission products and radioactive corrosion products in the primary circuit of the BN-350 reactor during operation at power levels of up to 650 MW with defective fuel elements in the core. Data are also given on radiation conditions in the reactor building, dose burden to personnel and activity loss from the primary circuit. The experimental data thus obtained are compared with design data.

24062 **Plenum-2A, a program for transient analysis of liquid-metal fast breeder reactor outlet plenums.** Carbajo, J.J.; Howard, P.A. (Argonne National Lab., IL). *Nucl. Technol.;* **47**: No. 2, 244-256(Feb 1980).

A new computer program, PLENUM-2A, has been developed to predict the conditions in the outlet plenum of a liquid-metal fast breeder reactor after a transient scram. This program divides the tansient into three main consecutive discrete states. Two additional stages, one occurring before the transiet begins and the other occurring as the transient ends, are also considered. The three main stages are described in detail, and calculations and experimental results are compared. The agreement between the calculations and experimental data is very good.

24063 **Ultrasonic inspection of liquid-metal fast breeder reactor steam generator duplex tubing.** Longua, K.J.; Whitham, G.K.; Allen, C.C. (Argonne National Lab., Idaho Falls). *Nucl. Technol.;* **47**: No. 2, 257-267(Feb 1980).

Two ultrasonic inspections of the Experimental Breeder Reactor II steam generator duplex tubing have been completed. Inspections performed on one evaporator in 1976 provided baseline data, and a subsequent inspection in 1978 revealed no change in tube condition. With the completion of the 1978 inspection, all available tubes in one evaporator have been inspected. The steam generator contains duplex tubes fabricated from 2 1/4 Cr-1 Mo ferritic steel. Access to the bore (water) side of the tubes was gained through the steam outlet piping. The inspection included a complete volumertic (100% of the tube material) examination, measurement of wall thickness, and evaluation of the condition of the braze bonding the two walls of the tube together. The test equipment was routinely calibrated against a standard containing artificial flaws. Artificial flaws as small as 1.6 mm long x 0.25 mm deep were readily detected.

24064 **Evaporative removal of sodium from reactor components.** Welch, F.H.; Steele, O.P. III. (Rockwell International Energy Systems Group, Canoga Park, CA). *Nucl. Technol.;* No. 2, 282-307(Feb 1980).

Evaporation of sodium from components using heat and vacuum was investigated as a method of sodium removal from liquid-metal fast breeder reactor components. The method was determined to be capable of efficiently cleaning components at temperatures as low as 260 to 315°C and at pressures of ~ 1 x 10^{-3} to 1 x 10^{-4} Pa. The most rapid cleaning was observed with small crevices, where the sodium is expelled by gases released from the sodium. The method was recommended as a viable process that should be investigated using full-size components.

24065 **Self locking drive system for rotating plug of a nuclear reactor.** Brubaker, J.E. US Patent 4,178,208. 11 Dec 1979. Filed date 23 Feb 1978. 8p.

PAT-APPL-880,679.

A self locking drive system for rotating the plugs on the head of a nuclear reactor which is able to restrain plug motion if a seismic event whould occur during reactor refueling is described. A servomotor is engaged via a gear train and a bull gear to the plug. Connected to the gear train is a feedback control system which allows the motor to rotate the plug to predetermined locations for refueling of the reactor. The gear train contains a self locking double enveloping worm gear set. The worm gear set is utilized for its self locking nature to prevent unwanted rotation of the plugs as the result of an earthquake. The double enveloping type is used because its unique contour spreads the load across several teeth providing added strength and allowing the use of a conventional size worm.

REGULATION AND LICENSING

24066 **Device and method for shortening reactor process tubes.** Frantz, C.E.; Alexander, W.K.; Lander, W.E.B. US Patent Application 005,947. [nd]. 17p.

A device and method are described for in situ shortening of nuclear reactor zirconium alloy process tubes which have grown as a result of radiation exposure. An upsetting technique is utilized which involves inductively heating a short band of a process tube with simultaneous application of an axial load sufficient to cause upsetting with an attendant decrease in length of the process tube.

24067 (RDT-M—3-34T(4-80)(Rev.)) **Nuclear standards transmittal.** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). 14 May 1980. 14p. RSO.

This standard covers carbon steel and medium- and high-alloy steel pipe and tubing for nuclear and associated applications.

24068 (RDT-M—3-4T(4-80)(Rev.)) **Nuclear standards transmittal.** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). 14 May 1980. 10p. RSO.

This standard covers nickel alloy seamless tubes for nuclear and associated applications.

ECONOMICS

REFER ALSO TO CITATION(S) 23850

FUEL CYCLE

24069 (ORNL/TM—7150) **ACFAC: a cash flow analysis code for estimating product price from an industrial operation.** Delene, J.G. (Oak Ridge National Lab., TN (USA)). Apr 1980. Contract W-7405-ENG-26. 55p. Dep. NTIS, PC A04/MF A01.

A computer code is presented which uses a discountted cash flow methodology to obtain an average product price for an industrial process. The general discounted cash flow method is discussed. Special code options include multiple treatments of interest during construction and other preoperational costs, investment tax credits, and different methods for tax depreciation of capital assets. Two options for allocating the cost of plant decommissioning are available. The FORTRAN code listing and the computer output for a sample problem are included.

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

24070 (CONF-791051—23) **Covariances of fission-integral measurements at the NBS ^{252}Cf and ISNF facilities and at the ORNL-PCA facility.** Wagschal, J.J.; Maerker, R.E.; Gilliam, D.M. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 11p. NTIS, PC A02/MF A01.

From 3. ASTM-EURATOM symposium on reactor dosimetry; Ispra, Italy (1 Oct 1979).

Integral measurements together with accompanying uncertainty estimates have been used for the past fifteen years in cross section adjustments. As the field of cross section adjustment came of age, the crude uncertainty estimates were replaced - only in principle, initially - by a quantitative cross section uncertainty covariance description and by uncertainty correlations of integral experiments. There is current interest in the fission reaction rate ratio measurements in the NBS standard neutron fields by people involved in fast reactor cross sections. Also those in the LWR pressure vessel

surveillance dosimetry program are interested in these measurements and in similar measurements performed in the Oak Ridge Pool Critical Assembly (PCA). A careful re-examination of uncertainty analysis is presented.

24071 (CONF-791186—1) **Solving the nuclear reactor core problems.** Vondy, D.R. (Oak Ridge National Lab., TN (USA)). Nov 1979. Contract W-7405-ENG-26. 24p. NTIS, PC A02/MF A01.

From Specialist meeting on neutronic calculational methods; Karlsruhe, F.R. Germany (22 Nov 1979).

The application of computer codes and mathematical models to the solution of problems concerning power reactor core kinetics is discussed.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 24363, 24392, 24417, 24446

24072 (ALO—63) **Users manual data base MATSURV. Reactor pressure vessel material surveillance data management system.** Kenworthy, L.D.; Tether, C.D. (International Energy Associates Ltd., Washington, DC (USA)). Feb 1980. Contract EY-76-C-04-0789. 118p. (IEAL—120). Dep. NTIS, PC A06/MF A01.

This Users Guide to the data management system MATSURV has been prepared to assist the user in all facets of the task of processing data related to reactor pressure vessel materials surveillance; preparation of raw data for input, input of data, modification of existing data, retrieval and display of data, and the creation of data reports. MATSURV is structured upon the System 2000 data base management system which is maintained on the IBM 370/168 computer at National Institutes of Health. An overview of System 2000 is provided.

24073 (BNL-NUREG—27192) **Relating surveillance capsule measurements to pressure vessel damage.** Carew, J.F.; Min, D.K.; Aronson, A.L. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 7p. (CONF-800607—24). Dep. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

As part of the pressure vessel (PV) materials surveillance program, surveillance capsules including material specimens and neutron flux dosimeters are generally required to monitor changes in the fracture toughness properties of the reactor vessel materials. These capsules are withdrawn sequentially according to a predetermined schedule covering the service life of the vessel, and specimen material changes and dosimeter activation measured. The neutron fluence accumulated by the flux dosimeters is determined from the measured dosimeter activation and known reaction cross section (in practice, the $^{54}Fe(n,p)^{54}Mn$ reaction.) The capsule fluence and material changes are then extrapolated to the pressure vessel using a fluence lead-factor determined from detailed multigroup neutron transport calculations. Typically, in this extrapolation changes in neutron spectrum are neglected. The purpose of this study is twofold; first, to determine the effect of including spectral changes in the extrapolation from capsule to vessel and second, to evaluate the effect of using the latest ENDF/B-V $^{54}Fe(n,p)^{54}Mn$ cross sections in converting dosimeter activation to fluence.

24074 (EPRI-EL—1263, pp 11.1-11.12) **Minimizing fire potential in power plant cable systems.** Garland, J.J. (Philadelphia Electric Co., PA). Nov 1979.

From Conference on electrical insulation and dielectric phenomena; Schenectady, NY, USA (17 Oct 1977).

Objectives in planning power plant cable systems with respect to fire include a design so that they will neither propagate a fire or contribute to the intensity of the fire, installation so that their exposure to fire is minimized, and to design and install them so that they will operate as long as possible during a fire to effect a safe shutdown.

24075 (EPRI-EL—1263, pp 12.1-12.5) **Special reporter comments and questions.** Opp, D.A. (IBM Corp., Endicott, NY). Nov 1979.

From Conference on electrical insulation and dielectric phenomena; Schenectady, NY, USA (17 Oct 1977).

The effect of environmental conditions, energy flux levels, oxygen/gaseous products, radiation/convection effects, and rates of combustion on electric cable fires are discussed. (FS)

FUEL ELEMENTS

24076 **Method and means of packaging nuclear fuel rods for handling.** Adam, M.F. (to Dept. of Energy). US Patent 4,170,817. 16 Oct 1979. Filed date 2 May 1978. 4p.

PAT-APPL-902,184.

Nuclear fuel rods, especially spent nuclear fuel rods that may show physical distortion, are encased within a metallic enclosing structure by forming a tube about the fuel pod. The tube has previously been rolled to form and overlapping tubular structure and then unrolled and coiled about an axis perpendicular to the tube. The fuel rod is inserted into the tube as the rolled tube is removed from a coiled strip and allowed to reassume its tubular shape about the fuel rod. Rollers support the coiled strip in an open position as the coiled strip is uncoiled and allowed to roll about the fuel rod.

CONTROL SYSTEMS

24077 **Assessment of new instrumentation and control technologies. Remote multiplexing. A case study.** Long, A.B. (Electric Power Research Inst., Palo Alto, CA (USA)). pp 191-206 of Nuclear power plant control and instrumentation, 1978. Vol. 2. Vienna, Austria; International Atomic Energy Agency (1978).

From IAEA symposium on nuclear power plant control and instrumentation; Cannes, France (24 Apr 1978).

New instrumentation and control technologies must be justified for application in power plants on the basis of improved plant performance and reduced investment costs. This justification requires that capability differences among systems be identified and that implementation schemes be selected which permit meaningful comparisons. A simple evaluation of initial investment costs is frequently inadequate because it does not account for operational expenses or resulting changes in plant performance. As an example of a more comprehensive evaluation methodology, this paper reviews the procedures and results from a recently completed study of remote multiplexing funded by the Electric Power Research Institute (EPRI). In this study it was found that plant-wide multiplexing of non-safety instrumentation and control signals is technically feasible, can be designed to satisfy availability requirements, may save millions of dollars as a hardwire replacer, and can provide other significant intangible benefits.

24078 (CONF-800627—1) **Operator support through modern optimal estimation and control.** Burdick, G.R. (Idaho National Engineering Lab., Idaho Falls (USA)). 1980. Contract AC07-76IDO1570. 8p. NTIS, PC A02/MF A01.

From Halden project conference; Halden, Norway (1 Jun 1980).

Applications of Modern Optimal Estimation and Control Theories are late in coming to the nuclear industry. Some features of the theories that might be exploited in nuclear systems applications are described. Activities at the Idaho National Engineering Laboratory relating to operator support using those theories are identified and some implementation challenges are discussed.

24079 (PNL-TR—397) **Ensuring safe operation of the BOR-60 experimental fast reactor as an atomic power plant.** Gryazed, V.M.; Antipin, G.K.; Afanas'ev, V.A.; Britov, V.N.; Efimov, V.N.; Kondrat'ev, V.I.; Kon'kov, V.F.; Smirnov, A.M. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 14 Apr 1980. Translation of IAEA-SM-225/68, pp. 177-189. (CONF-780407—10). 23p. NTIS, PC A02/MF A01.

From Symposium on design, construction and operating experience of demonstration liquid metal fast breeder reactors; Bologna, Italy (10 Apr 1978).

On the basis of the BOR-60 facility an analysis is made of characteristic requirements for safe operation of a fast-reactor power plant, from the standpoint of stability against perturbations in the operation of the main components and systems and against deviations from the design values of process parameters. The self-regulation properties of the facility are discussed. Regulation by neutron flux and by sodium outlet temperature are compared from the point of view of increasing the reliability of the control system and minimizing temperature strains in the components during transient processes. Calculated and experimental data are presented on optimization of emergency shut-down and cooling regimes using different combinations of equipment. The means and methods used to verify the state of the reactor vessel, fuel assemblies and in-vessel reactor systems during operation on power and during reloading are described: operating experience with sodium/water steam generators is analyzed, as is the use of leak verification, control and protection for steam generators under accident conditions.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 23798, 23849

24080 (ALO—81) **Tentative outline of work scope and organization for a study of the risks from energy production in the US.** Cave, L.; Okrent, D.; Pery, G. (California Univ., Los Angeles (USA).

Dept. of Chemical, Nuclear, and Thermal Engineering). Apr 1980. Contract EY-76-C-04-0789;ET-78-S-04-5450. 43p. (UCLA-ENG—7941). NTIS, PC A03/MF A01.

The risk assessment of nuclear energy in the US is compared to other energy sources.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 24078, 24079, 24087, 24098

24081 (EGG/LTR-LO—0080-113) **LOFT Experimental Programs Division. Volume II. Calibration of the LOFT modular DTT and the LOFT production DTT with a small drag disc.** Solbrig, C.W.; Shull, G.B.; Good, R.R.; Chen, L.L.; Reimann, J.; John, H.; Loeffel, R. (Idaho National Engineering Lab., Idaho Falls (USA)). 11 Feb 1980. Contract EY-76-C-07-1570. 253p. Dep. NTIS, PC A12/MF A01.

Phase II of the LOFT Test program in Germany, consisted of two-phase flow calibrations in the three-inch pipe. The instruments intended for calibration were the LOFT Modular Drag Disk Turbine Transducer (MDTT) and a three-beam gamma densitometer. The DTT is of the modular design and is representative of the type to be used in the LOFT L2 (nuclear) series. The test section provides free field calibrations; that is, the DTT is smaller than the inside diameter of the test section. The gamma densitometer is a three beam unit representative of the configuration used in LOFT, but modified to fit on a smaller pipe.

REACTOR SAFETY

REFER ALSO TO CITATION(S) 24080

24082 (ALO—66) **Metholology for the selection of LWR safety R & D projects. Phase I, status report.** El-Sheikh, K.A. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Mar 1980. Contract EY-76-C-04-0789. 82p. (GE/ARSD—00027). NTIS, PC A05/MF A01.

The objective of the LWR R & D Selection Methodology Program is to develop and demonstrate an R & D selection methodology appropriate for LWR safety technology. This report documents the development work from the program beginning in April, 1979 to the end of Fiscal Year 1979. The scope of work for this period included three tasks; methodology review (Task 1), measures development (Task 2), and methodology development for the first phase of application (Task 3). The accomplishments of these tasks are presented.

24083 (CONF-791049—26) **Plenary lecture - a special radioelement problem: ORNL assistance to Three Mile Island in handling contaminated air and water.** Brooksbank, R.E. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 44p. NTIS, PC A03/MF A01.

From 23. conference on analytical chemistry in energy technology; Gatlinburg, TN, USA (9 Oct 1979).

As the investigative work concerning the post-accident period comes to light, it is apparent that ORNL has played a significant role in the recovery of TMI. Work in the area of waste handling, analytical service, flowsheet development, and decontamination are all regarded as significant. Efforts in this specific area of assistance to TMI are really the results of the close working relationship between chemical engineers and analytical chemists. The two major areas of involvement, and the subject of this discussion, are contaminated air and water handling which resulted from the accident.

24084 (CONF-791058—71) **Fission product decay heat for thermal reactors.** Dickens, J.K. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 9p. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

In the past five years there have been new experimental programs to measure decay heat (i.e., time dependent beta- plus gamma-ray energy release rates from the decay of fission products) following thermal-neutron fission of ^{235}U, ^{239}Pu, and ^{241}Pu for times after fission between 1 and $\sim 10^8$ sec. Experimental results from the ORNL program stress the very short times following fission, particularly in the first few hundred sec. Complementing the experimental effort, computer codes have been developed for the computation of decay heat by summation of calculated individual energies released by each one of the fission products. By suitably combining the results of the summation calculations with the recent experimental results, a new Decay Heat Standard has been developed for application to safety analysis of operations of light water reactors. The new standard indicates somewhat smaller energy release rates than those being used at present, and the overall uncertainties assigned to the new standard are much smaller than those being used at present.

24085 (CONF-791118—10) **Development of impedance sensors at ORNL: for measurement of two-phase flows.** Eads, B.G.; Hylton, J.O. (Oak Ridge National Lab., TN (USA)). 30 Oct 1979. Contract W-7405-ENG-26. 36p. NTIS, PC A03/MF A01.

From 7. water reactor safety research information meeting; Gaithersburg, MD, USA (5 Nov 1979).

Techniques and equipment have been developed to measure in-vessel local void fraction and velocity in a reflood transient test facility. The two impedance sensors, the flag probe and the string probe, have been tested (prototype sensors) in a variety of air-water and steam-water facilities an in all cases acceptable measurement results were obtained.

24086 (CONF-800434—2) **ORNL experiments to characterize fuel release from the reactor primary containment in severe LMFBR accidents.** Wright, A.L.; Kress, T.S.; Smith, A.M. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

This paper presents results from aerosol source term experiments performed in the ORNL Aerosol Release and Transport (ART) Program sponsored by the US NRC. The tests described were performed to provide information on fuel release from an LMFBR primary containment as a result of a hypothetical core-disruptive accident (HCDA). The release path investigated in these tests assumes that a fuel/sodium bubble is formed after disassembly that transports fuel and fission products through the sodium coolant and cover gas to be relased into the reactor secondary containment. Due to the excellent heat transfer characteristics of the sodium, there is potential for large attenuation of the maximum release.

24087 (CONF-800536—1) **Modeling a nuclear reactor for experimental purposes.** Berta, V.T. (Idaho National Engineering Lab., Idaho Falls (USA)). 1980. Contract EY-76-C-07-1570. 19p. NTIS, PC A02/MF A01.

From American Engineering Model Society seminar '80; Pittsburgh, PA, USA (5 May 1980).

The Loss-of-Fluid Test (LOFT) Facility is a scale model of a commercial PWR and is as fully functional and operational as the generic commercial counterpart. LOFT was designed and built for experimental purposes as part of the overall NRC reactor safety research program. The purpose of LOFT is to assess the capability of reactor safety systems to perform their intended functions during occurrences of off-normal conditions in a commercial nuclear reactor. Off-normal conditions arising from large and small break loss-of-coolant accidents (LOCA), operational transients, and anticipated transients without scram (ATWS) were to be investigated. This paper describes the LOFT model of the generic PWR and summarizes the experiments that have been conducted in the context of the significant findings involving the complex transient thermal-hydraulics and the consequent effects on the commercial reactor analytical licensing techniques. Through these techniques the validity of the LOFT model as a scaled counterpart of the generic PWR is shown.

24088 (CONF-800607—15) **Assessment of molten debris freezing in a severe RIA in-pile test.** El-Genk, M.S.; Moore, R.L. (EG and G Idaho, Inc., Idaho Falls (USA)). 1980. Contract EY-76-C-07-1570. 5p. Dep. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

An understanding of the freezing of molten debris on cold core structures following a hypothetical core meltdown accident in a light water reactor (LWR) is of importance to reactor safety analysis. The purpose of the present investigation was to analyze the transient freezing of the molten debris produced in a severe reactivity initiated accident (RIA) scoping test, designated RIA-ST-4, which was performed in the Power Burst Facility and simulated a BWR control rod drop accident. In the RIA-ST-4 experiment, a single, unirradiated, 20 wt % enriched, UO_2 fuel rod contained within a Zircaloy flow shroud was subjected to a single power burst which deposited a total energy of about 700 cal/g UO_2. This energy deposition is well above what is possible in a commercial LWR during a hypothetical control rod drop (BWR) or ejection (PWR) accident. However, the performance of such an in-pile test has provided important information regarding molten debris movement, relocation, and freezing on cold walls.

24089 (COO—2571-19) **Improvement and verification of fast reactor safety analysis techniques. Progress report, October 1, 1979-March 31, 1980.** Barker, D.H.; Wiberg, D.V. (Brigham Young Univ., Provo, UT (USA). Dept. of Chemical Engineering). 1980. Contract AC02-76ET37205. 7p. NTIS, PC A02/MF A01.

Several of the time dependent properties of the dimethyl sulfoxide-acetyl chloride reaction system were determined. The

volume of a wax cylinder melted by conducting a dimethyl sulfoxide-acetyl chloride reaction in the vessel was compared with the melted volume calculated using several different heat transfer correlations. It was found that a laminar flow at the wall model provided the most accurate calculation of the observed melted volume.

24090 (COO—4261-14) **Growth of molten core debris pools in concrete. Part II. A. Pool growth in composite beds; B. Effect of overlaying steel layers. Final report, March 1, 1978-September 30, 1979.** Abdel-Khalik, S.I. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). 26 Dec 1979. Contract EN-77-S-02-4261. 47p. Dep. NTIS, PC A03/MF A01.

The heat and mass transfer processes taking place in molten core debris/concrete systems have been experimentally investigated. Two types of experiments have been conducted. The first experiment simulates the growth of a molten debris pool in a composite sacrificial bed. This experiment models debris pool growth in an inner, low-melting point, sacrificial material zone followed by a melting attack on the concrete bed. The purpose of the inner zone is to quickly melt and dilute the debris pool so that its subsequent downward growth in the concrete may be slowed. In the second experiment a two-layer immiscible liquid system is volumetrically heated and allowed to melt into a low-density gas releasing solid bed which is miscible in the initially-higher-density bottom liquid. The solid melts, mixes with, and dilutes the bottom liquid pool until its density is lower than that of the top liquid.

24091 (DOE/ET/37205—T1) **Chemical simulation modeling of heat transfer in LMFBRs.** Wiberg, D.V. (Brigham Young Univ., Provo, UT (USA). Dept. of Chemical Engineering). Apr 1980. Contract AC02-76ET37205. 126p. NTIS, PC A07/MF A01.

Thesis.

A chemical reaction conducted in a wax cylinder was used in this study to simulate a CDA occurring in a reactor. The exothermic reaction of dimethyl sulfoxide (DMSO) with acetyl chloride (AC) was used as the chemical reaction to simulate the internally heated liquid pool. SUN-3420 wax was used to construct the cylindrical reaction vessel to simulate cladding and containment.

24092 (EGG-FM—5078) **Water loss in fast project interim fuel storage rack.** Kelsey, P.V. Jr. (Department of Energy, Idaho Falls, ID (USA). Idaho Operations Office). Jan 1980. Contract EY-76-C-07-1570. 24p. Dep. NTIS, PC A02/MF A01.

Water loss calculations for the concrete FAST interim fuel storage rack were performed at the request of Exxon Nuclear. Because water in concrete, whether chemically combined or in a free state, is a critical component for neutron attenuation and radiation shielding, loss of water within a concrete structure designed to contain various forms of nuclear material could present a criticality problem within the structure. Although a definitive optimum water content has not been presented at this time, it appears that 4 weight % is a minimum content for efficient attenuation. Although other elements in concrete contribute to neutron attenuation, hydrogen with its large cross section is the dominant attenuating element. The results of calculations indicate that the present design of the fuel rack is inadequate for the proposed total fluence and that the minimum safe water content would be reached within one year's operation.

24093 (HEDL-TME—75-85) **TEMP: a computer code to calculate fuel pin temperatures during a transient.** Bard, F.E.; Christensen, B.Y.; Gneiting, B.C. (Hanford Engineering Development Lab., Richland, WA (USA)). Apr 1980. Contract EY-76-C-14-2170. 293p. NTIS, PC A13/MF A01.

The computer code TEMP calculates fuel pin temperatures during a transient. It was developed to accommodate temperature calculations in any system of axi-symmetric concentric cylinders. When used to calculate fuel pin temperatures, the code will handle a fuel pin as simple as a solid cylinder or as complex as a central void surrounded by fuel that is broken into three regions by two circumferential cracks. Any fuel situation between these two extremes can be analyzed along with additional cladding, heat sink, coolant or capsule regions surrounding the fuel. The one-region version of the code accurately calculates the solution to two problems having closed-form solutions. The code uses an implicit method, an explicit method and a Crank-Nicolson (implicit-explicit) method.

24094 (LA-UR—80-1069) **Fuel damage estimates for the TMI-2 reactor.** Kirchner, W.L.; Ireland, J.R.; Mast, P.K. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 8p. (CONF-800403—42). NTIS, PC A02/MF A01.

From ANS thermal reactor safety meeting; Knoxville, TN, USA (8 Apr 1980).

A best-estimate postaccident analysis of the TMI-2 reactor system was made with the TRAC code. Based on these results, an assessment of the extent of damage to the TMI-2 reactor core was made; and several alternative event sequences and their consequences were investigated. Results indicate that although no significant fuel melting occurred, large regions of cladding were severely oxidized and clad melting and relocation took place in the central region of the core, above the midplane elevation. In the alternative event sequences, the timeliness of the initiation of HPI flow in preventing large scale fuel melting is examined.

24095 (ORNL/TM—7211) **Modeling decay heat-induced melting of a concrete slab by use of the general heat conduction code HEATING 5.** Tobias, M.L. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 39p. NTIS, PC A03/MF A01.

The problem of the interaction between a reactor-size mass of UO_2 generating decay heat and an underlying slab of concrete has been approached through use of the general heat conduction code, HEATING 5. A number of complex effects are considered, including fuel evaporation and concrete dissolution, through user-written subroutines that can be included without disturbing the main portion of the code. The calculated melt front movement rate is about 3.5 x 10^{-6} m/s at an interface heat flux of about 5 W/cm. Sandia Laboratory experimental data for plasma heating of concrete specimens at 274 W/cm^2, if renormalized to the same heat flux, give a rate of about 2.9 x 10^{-6} m/s.

24096 (SAN—0115-T7) **Nonequilibrium phenomena in flashing water used as an HCDA source simulant. Technical report No. 8.** Tobin, R.J.; Cagliostro, D.J.; Florence, A.L. (SRI International, Menlo Park, CA (USA). Poulter Lab.). Nov 1979. Contract EY-76-C-03-0115-097. 118p. Dep. NTIS, PC A06/MF A01.

The philosophy behind the design of liquid metal fast breeder reactors (LMFBR) is to keep the risk to the public from accidental releases of radioactivity extremely small. Consistent with this philosophy, LMFBR safety technology research sponsored by DOE includes the consideration of hypothetical core disruptive accidents (HCDA). Recent scale-model simulation experiments on HCDAs identified nonequilibrium phenomena in flashing liquids as a possible attenuation mechanism in the energetics of flashing reactor fuels during an HCDA.

24097 (SAND—80-0888C) **Best-estimate LOCA radiation signature for equipment qualification.** Lurie, N.A.; Bonzon, L.L. (IRT Corp., San Diego, CA (USA); Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 8p. (CONF-800403—37). Dep. NTIS, PC A02/MF A01.

From ANS thermal reactor safety meeting; Knoxville, TN, USA (8 Apr 1980).

The radiation aspect of reactor equipment qualification depends on a knowledge of the appropriate source term. An attempt has been made to define a realistic radiation source corresponding to the loss-of-coolant accident. This best-estimate source is based on available fission product release data from damaged fuel during an unterminated LOCA as described in the Reactor Safety Study (WASH-1400). Energy release rates as a function of time have been calculated for both betas and gamma rays. The results are significantly different from the sources specified in Regulatory Guide 1.89. Spectra corresponding to the best-estimate source have also been computed at selected cooling times.

24098 **Containment response to postulated core meltdown accidents in the fast flux test facility.** Gasser, R.D.; Pratt, W.T. (Brookhaven National Lab., Upton, NY). *Nucl. Technol.;* **47**: No. 2, 282-307(Feb 1980).

An assessment is made of the containment margin available in the Fast Flux Test Facility to mitigate the consequences of a postulated failure of in-vessel post-accident heat removal following a hypothetical core disruptive accident. The consequences of a number of assumed meltdown configurations (both in-vessel and ex-vessel) are assessed using the CACECO (CAvty, CEll, COntainment) containment analysis computer code together with currently available melt front penetration models. The sensitivity of the accident scenarios to a number of crucial assumptions is established by scoping studies. It is concluded from both the in-vessel and exvessel analyses that sodium vapor combustion is a major source of reactor containment building (RCB) pressurization. The conditions (a combination of sodium-concrete reaction, pool size, and decay heat level) that most rapidly bring the sodium to boiling, together with those that enhance mass transfer of sodium vapor to the RCB, are the ones that most significantly affect the pressure response.

ENERGY STORAGE

REFER ALSO TO CITATION(S) 24022, 25057, 25058

MAGNETIC

REFER ALSO TO CITATION(S) 25056

PUMPED HYDRO

REFER ALSO TO CITATION(S) 23794

CAPACITOR BANKS

REFER ALSO TO CITATION(S) 25060

FLYWHEELS

REFER ALSO TO CITATION(S) 24347, 24372, 25059

24099 (CONS—5085-T2) **Low-cost flywheel demonstration program. Final report, 1 October 1977-31 December 1979.** Rabenhorst, D.W.; Small, T.R.; Wilkinson, W.O. (Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab.). Apr 1980. Contract EC-77-C-01-5085. 111p. NTIS, PC A06/MF A01.

The Applied Physics Laboratory/Department of Energy Low Cost Flywheel Demonstration Program was initiated on 1 October 1977 and was successfully concluded on 31 December 1979. The total cost of this program was $355,190. All primary objectives were successfully achieved as follows: demonstration of a full-size, 1-kWh flywheel having an estimated cost in large-volume production of approximately $50/kWh; development of a ball-bearing system having losses comparable to the losses in a totally magnetic suspension system; successful and repeated demonstration of the low-cost flywheel in a complete flywheel energy-storage system based on the use of ordinary house voltage and frequency; and application of the experience gained in the hardware program to project the system design into a complete, full-scale, 30-kWh home-type flywheel energy-storage system.

THERMAL

REFER ALSO TO CITATION(S) 23896, 23975, 23976, 23977, 23978, 24249

24100 (CONF-791108—24) **Some observations on a paraffin-wax phase change experiment.** Deal, R.M.; Solomon, A.D. (Kalamazoo Coll., MI (USA). Dept. of Chemistry; Union Carbide Corp., Oak Ridge, TN (USA). Nuclear Div.). 1979. Contract W-7405-ENG-26. 18p. Dep. NTIS, PC A02/MF A01.

From 72. AICHE meeting; San Francisco, CA, USA (25 Nov 1979).

Some melting and freezing experiments with N-Octadencane paraffin wax are described. Their results are analyzed using a variety of mathematical techniques for conduction phase-change problems. It is concluded that the thermal conductivity of the solid wax used in the tests should be about 3.5 times the literature value.

24101 (CONF-7910152—1) **Evaluation of thermal energy storage for a large urban hot water district heating system in the United States.** Meyer, C.F. (General Electric Co., Santa Barbara, CA (USA). Center for Advanced Studies). Jul 1979. Contract W-7405-ENG-26. 26p. NTIS, PC A03/MF A01.

From 2. international total energy congress; Copenhagen, Denmark (8 Oct 1979).

A large new cogeneration-district heating system has been proposed for the Twin Cities (Minneapolis-St. Paul) area in Minnesota, using hot water. The system as proposed does not include thermal energy storage (TES). Four different modifications of the system configuration to include annual-cycle TES have been postulated and studied to evaluate potential benefits of the TES. Aquifer TES would permit large amounts of hot water, produced when cogeneration capacity exceeds the demand for heat, to be stored in natural underground formations until it is needed to help meet winter space-heating demands. Approximately three-fourths of the heat stored is estimated to be recoverable, assuming suitable geologic formations are available. Use of aquifer TES can serve the same function as oil-fired boilers for peak load and standby reserve requirements, making the boilers and the burning of oil unnecessary. Coal-fired cogeneration equipment would produce the heat otherwise furnished by boilers and replace the heat lost during storage, by operating at a higher capacity factor. The net energy savings of the proposed system without TES are impressive. When TES is used, the net energy saved is found to be 2 to 14% greater, in spite of heat lost during storage with fuel cost savings of $14 to $16 million per year. Reduction of air and thermal pollution are concomitant benefits. The capital investment requirements for boilers, cogeneration equipment, and transmission pipelines might be reduced by $66 to $122 million. The breakeven capital cost of aquifer TES is found to be from $43 to $59 per peak thermal kilowatt input to or withdrawal from storage.

CHEMICAL

REFER ALSO TO CITATION(S) 24234

BATTERIES

24102 **Twenty-eighth power sources symposium.** Princeton, NJ; Electrochemical Society, Incorporated (1978). 284p. (CONF-780624—).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

A separate abstract was prepared for 77 of the papers included in these proceedings. The remaining two have already been cited in ERA, and can be located by reference to the entry CONF-780624— in the Report Number Index. (RWR)

DESIGN AND DEVELOPMENT

24103 (ANL—80-32) **Development of advanced batteries at Argonne National Laboratory. Summary report for 1979.** (Argonne National Lab., IL (USA)). Apr 1980. Contract W-31-109-ENG-38. 46p. NTIS, PC A03/MF A01.

A summary for 1979 of Argonne National Laboratory's program on the development of advanced batteries is presented. These batteries are being developed for electric-vehicle propulsion and stationary energy-storage applications. The principal cells under investigation at present are of a vertically oriented, prismatic design with one or more inner positive electrodes of FeS or FeS_2, facing negative electrodes of Li-Al alloy, and molten LiCl-KCl electrolyte; the cell operating temperature is 400 to 500°C. A small effort on the development of a calcium/metal sulfide cell is also being conducted. During 1979, cell and battery development work continued at ANL and contractors' laboratories. A 40-kWh electric-vehicle battery (designated Mark IA) was fabricated and delivered by Eagle-Picher Industries, Inc. to ANL for testing. During heat-up, one of the modules failed due to a short circuit. A failure analysis was conducted, and the Mark IA program, completed. Development work on the next electric-vehicle battery (Mark II) was initiated at Eagle-Picher and Gould, Inc. Work on stationary energy-storage batteries consisted primarily of conceptual design studies. 9 figures, 7 tables.

24104 **Design and testing of a large-scale lithium-silicon/FeS load-leveling cell.** Hall, J.C. (Rockwell International, Canoga Park, CA). pp 17-20 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Component and cell design, fabrication, and performance of a 2.5-kWh module envisioned for a 100-MWh utility load-leveling battery are described. Feasibility of this full-sized module was demonstrated. The cause of an unexpectedly early short circuit is analyzed; it was possible to repair and partially restore the cell. 5 figures, 2 tables. (RWR)

24105 **Electrochemical generator based upon molten fluorides.** Chauvin, G.; Coriou, H.; Dixmier, J.; Hardy, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France). pp 20-22 of Twenty-eighth power sources syposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Results of experiments using LiF-NaF-KF eutectic at 550°C are reported. Cells of the type Na/LiF-NaF-KF + NiF_2/Ni had the following characteristics: 2.05 V, 20 mA/cm², 120 Wh/kg, 120 h service life. This cell seems capable of improvement. Other materials were also tried, and they performed as follows: Li-Al/LiF-NaF-KF + NiF_2/Ni: 2.0 V, 30 mA/cm², 122 Wh/kg, 105 h; Li-Al/LiF-NaF-KF + FeS/graphite: 1.5 to 1.7 V, 40 mA/cm², 120 Wh/kg, 60 h. Cells similar to the first one above but with a solid Al anode have these characteristics: 1.9 to 2.0 V, 30 mA/cm², 80 Wh/kg, 420 h, 30 cycles. 4 figures. (RWR)

24106 **50 kW-hr zinc-chlorine hydrate battery.** Carr, P.; Chi, C.H.; Symons, P.C. (Energy Development Associates, Madison Heights, MI). pp 23-26 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Specifications for a battery capable of powering a four-passenger electric vehicle are given first. The design, building, and testing of a battery to meet these specifications are discussed, including basic electrochemical concepts, systems design, and performance. The battery operates successfully; however, increased efficiency and lower weight are necessary before commercialization. 5 figures, 1 table. (RWR)

24107 Studies on some non-standard systems for thermal battery applications. Dand, P.V.; Press, K.K.; Wisniewski, G.R. (KDI SCORE, Inc., Cockeysville, MD). pp 75-79 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Characteristics of the Ca/LiCl-KCl/$CaCrO_4$ system were investigated to determine ways of optimizing battery performance. In addition, Ca, Mg, and Li-Al alloy were evaluated as anodes against various cathodic materials including $CaCrO_4$, metal sulfides, metal oxides (CuO, Fe_2O_3, NiO, V_2O_5, WO_3), and $CuCl_2$. A eutectic mixture of LiCl and KCl was used as electrolyte. Effects of varying pellet density, pellet thickness, and electrolyte/depolarizer ratio are reported for the standard system. Voltage, service life, and energy density are given for various nonstandard combinations. The new systems are capable of greater energy densities at higher current densities (approx. 100 mA/cm^2) than the standard system. 9 figures, 3 tables. (RWR)

24108 Low temperature, long-life, pelletized LiAl/$CuCl_2$ single cell for thermal battery applications. Erbacher, J.K.; Hussey, C.L.; King, L.A. (Frank J. Seiler Research Lab., Denver, CO). pp 84-89 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

A new, pelletized, low-temperature thermal battery of LiAl/$NaAlCl_4$, sat. NaCl/$CiCl_2$ type for long-life (order of an hour) uses is presented. The behavior of this cell is studied with respect to current density, temperature dependence, anode composition, and cathode particle size. Voltage is plotted vs time (and temperature), and energy density vs temperature. 7 figures, 6 tables. (RWR)

24109 New electrochemical cells based upon molten nitrate salts. Fletcher, A.N.; Fine, D.A. (Naval Weapons Center, China Lake, CA). pp 92-94 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The possibility of extending the Li/$SOCl_2$ concept to a thermal cell where a highly conductive, oxidizing, molten salt would serve as the solvent was investigated. It was found that nitrate salts would not show exothermic reactions with Ca metal at temperatures well above 500°C. The temperature sensitivity of the Ca/$NaNO_3$/Ni cell is shown, along with cell potentials of $LiNO_3$ and KNO_3 as anolytes from 250 to 500°C. Peak voltage of the Ca/nitrate/V_2O_5/Ni cell at 375°C is plotted as a function of current density. Life to 80% of peak voltage is also shown for small cells of this type. Open circuit potentials of a variety of oxidizers with three different electrolyte combinations are tabulated. It is concluded that fused nitrate salts can be modified through the use of Lux-Flood acids and halide ions to serve either as the catholyte or as low-melting electrolytes with metal oxides as the primary catholyte. The feasibility of a thermal Li/$SOCl_2$-type cell was demonstrated. 4 figures, 2 tables. (RWR)

24110 Long life lightweight nickel-cadmium battery development. Ritterman, P.F. (TRW Defense and Space Systems Group, Redondo Beach, CA). pp 117-119 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Efforts toward developing lightweight batteries with improved performance and specific energy characteristics focused on achieving a ten-year geosynchronous orbit service life with an end-of-life usable specific energy of 22 Wh/kg. Electrode fabrication methods were evaluated, and post-teardown analyses were performed on tested cells. Characteristics of second-generation cells are reported. A battery system yielding 1200 W has a specific energy of 22.5 Wh/kg. 4 figures, 2 tables. (RWR)

24111 Sealed nickel cadmium cell design by computer modeling. Puglisi, V.J. (Yardney Electric Corp., Pawcatuck, CT). pp 127-130 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

A working code for design of aerospace Ni/Cd cells is described. 28 design parameters are enumerated. The FORTRAN program is listed. 4 tables. (RWR)

24112 Design of long life nickel hydrogen cells. Rogers, H.H.; Krause, S.J.; Levy, E. Jr. (Hughes Aircraft Co., Los Angeles, CA). pp 142-144 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The basic cell design is cylindrical pineapple plate using a recirculating oxygen and electrolyte concept with a wick external to the stack. A gas-permeable zirconium oxide cloth separator impregnated with polysulfone is used. Design and fabrication of cell stack and case are discussed from both electrochemical and mechanical points of view. Results of a typical capacity test are shown. 6 figures, 1 table. (RWR)

24113 Silver-hydrogen cells. Charkey, A.; Klein, M. (Energy Research Corp., Danbury, CT). pp 145-149 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Component development, cell design and optimization, and cell testing on simulated orbital regimes were performed. Ag/H_2 cell reactions, fabrication of the Ag electrode, the H_2 electrode, the separator materials, and the electrolyte reservoir are described. Tests of single-electrode cells and 20-Ah multielectrode cells were carried out, and the results are tabulated. Design analysis for 35-Ah lightweight cells is presented. It is concluded that the separator material will permit stable cycling of over 800 cycles in 20-Ah boiler plate-type cells. Decay in the performance of test cells was observed between 800 and 1000 cycles and also at 1500 cycles. Failure appeared to be due to impurities in the pores of the Ag electrode and corrosion of the current collector on the cathode, respectively. Remedies are proposed. Weight analysis suggests the possibility of a 35-Ah cell with 90 Wh/kg. 5 figures, 3 tables. (RWR)

24114 Iron-air battery characteristics. Bryant, W.A.; Liu, C.T.; Buzzelli, E.S. (Westinghouse Electric Corp., Pittsburgh, PA). pp 152-155 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Bifunctional air electrodes were prepared that exhibit discharge voltages of -0.100 V versus Hg/HgO at a current density of 50 mA/cm^2. High-capacity iron electrodes were prepared by powder metallurgy techniques. Half-cell discharge capacities as great as 0.475 Ah/g were achieved at a current density of 50 mA/cm^2. Iron-air cells having a projected active area of 100 cm^2 were fabricated and tested. When their power characteristics are projected to 400 cm^2 cells and reasonable assumptions are made for improvements in cell design, it is expected that these larger cells would deliver 80 watts per kilogram. Use of the best electrodes prepared to date could increase this output to about 110 watts per kilogram. 5 figures.

24115 Long-life rechargeable silver-zinc battery. Lear, J.W. (Martin Marietta Corp., Denver, CO). pp 173-175 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

A 12-V, 40-Ah battery for Titan II's security system coded switch assembly is described. Requirements and constraints, cell choice, cell design approach, battery packaging design, battery manufacture and acceptance testing, and battery performance are discussed. Several improvements made in battery design are noted. The engineering prototype batteries have operated for more than four years under the specified constraints and environments. Modified batteries have been operating in the field for over two years. 4 figures, 3 tables. (RWR)

24116 Manufacturing techniques for hermetically sealed lithium organic electrolyte cells. Watson, T.M. (Power Conversion, Inc., Mt. Vernon, NY). pp 192-195 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Techniques for manufacturing several thousand cells per day are discussed. These techniques encompass continuous anode/cathode fabrication, semiautomatic core winding of the laminate separator, electrolyte preparation and dispensing, and hermetic packaging of the components. Implementation of these techniques resulted in substantial reductions in fabrication time and labor costs. 8 figures. (RWR)

24117 Development of subminiature lithium-monofluorographite-organic electrolyte primary cells. Chireau, R.F. (Yardney Electric Corp., Pawcatuck, CT). pp 203-207 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Background and goals of the program are given first. Then the various components investigated in the experimental development program are discussed; the fluorocarbon cathode (monofluorographite material, conductive additives, binder, performance charac-

teristics), lithium anode, electrolyte, separator, cell design, and cell performance are described. The lithium-fluorocarbon cells developed have a diameter of about 2.5 mm and a length of about 19 mm. On average, 60 MWh was delivered by prototype cells when discharged at 1.5 mA/cm^2 to a cutoff voltage of 1.8 V. Specific energies obtained were 0.55 to 0.73 Wh/cm^3 at 20°C. 6 figures, 3 tables. (RWR)

24118 FeS/Li organic electrolyte cell. Uetani, Y.; Yokoyama, K.; Kawai, T. (Hitachi Maxell Ltd., Osaka, Japan). pp 219-221 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

FeS was found to be a suitable cathode material for a 1.5-V lithium/organic electrolyte cell. In the development of these cells, electrolyte screening and elucidation of the discharge reaction were addressed. Then completely sealed cells were constructed and tested. It was found that FeS was electrochemically active at ambient temperature in organic electrolyte, and could be used as the cathode in a FeS/Li cell. Propylene carbonate +- 1,2-dimethoxyethane was a suitable electrolyte. Working voltage of a button-type FeS/Li battery was 1.25 to 1.4 V, and the energy content, 60 to 83 mAh/g. 5 figures, 1 table. (RWR)

24119 Development of a lithium-water-air battery. Bauman, H.F.; Littauer, E.L. (Lockheed Missiles and Space Co., Inc., Palo Alto, CA). pp 229-232 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The design of lithium-water-air cell is described. The experimental program determined the effect of various levels of electrolyte flow velocity, air flow volume, and electrolyte concentration on cell potential. Performance of a cell with a Pt black catalyzed air cathode and of a five-cell battery is presented and discussed. 7 figures. (RWR)

24120 Lithium/thionyl chloride reserve cell development. Eppley, W.J.; Horning, R.J. (Honeywell Power Sources Center, Horsham, PA). pp 257-261 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Design of a Li/$SOCl_2$ electrochemical system to fit standard cell hardware is discussed. Performance characteristics of these cells are presented; typical discharge curves are plotted, along with the effect of discharge rate and storage on performance. While cell feasibility was demonstrated, further development work is needed. 7 figures, 2 tables. (RWR)

24121 Lithium thionyl chloride high rate reserve cells. Domeniconi, M.J.; Klinedinst, K.A. (GTE Labs., Inc., Waltham, MA). pp 262-265 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The performance characteristics of the Li/$SOCl_2$ cell were investigated as a function of discharge rate. Both the $LiAlCl_4$ electrolyte and the carbon black/PTFE cathode were modified with a view toward increased efficiency at high discharge rates. Use of pure $AlCl_3$ instead of $LiAlCl_4$ dissolved in $SOCl_2$ as the electrolyte more than doubled the discharge capacity for a given rate of discharge. Reductions in cathode thickness resulted in a doubling of the cathode utilization at high rates of discharge and an order-of-magnitude increase in the power generated per unit cathode volume. 8 figures. (RWR)

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 23851, 24104, 24106, 24108, 24161, 24165, 24168, 24334

24122 (CONF-781063—7) **Electrolysis of molten $NaNO_3$-$AgNO_3$ as test of a model of transport in batteries.** Vallet, C.E.; Heatherly, D.E.; Braunstein, J. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 11p. Dep. NTIS, PC A02/MF A01.

From 2. symposium on molten salts; Pittsburgh, PA, USA (15 Oct 1978).

Concentration changes resulting from electrolysis of 0.8 $NaNO_3$-0.2 $AgNO_3$ mixtures between silver electrodes were measured by potentiometric analysis during electrolysis (with current interruption); emf relaxation following electrolysis; chemical analysis of sections of frozen electrolyte. Enrichment in $NaNO_3$ at the cathode and in $AgNO_3$ at the anode are observed. The measurements confirm predictions from a model of component separation in mixed molten salt batteries with faradaic, migrational, and diffusional flows analogous to those in Li/LiCl-KCl/S batteries. 4 figures, 2 tables.

24123 (NTISUB/E—104-015) **Aircraft accident report - Champion Home Builders Company, Gates Learjet 25B, N999HG, Sanford, North Carolina, September 8, 1977.** (National Transportation Safety Board, Washington, DC (USA). Bureau of Accident Investigation). 20 Sep 1979. 31p. North American Continent price $40.00/year.

About 2020 e.s.t., on September 8, 1977, Champion Home Builders Company, Gates Learjet 25B, N999HG, crashed shortly after takeoff at Stanford, North Carolina. All five persons aboard were killed, and the aircraft was destroyed. The aircraft departed Sanford Airport about 2018 e.s.t., for a flight to Flint, Michigan. In accordance with departure instructions from Fayetteville departure control, the flight was about 3 mi west of the airport, climbing through 3,000 ft, on a heading of 270 degrees, when it disppeared from radar. There were no distress calls, but several witnesses west of the airport saw the aircraft on fire below the 600-ft overcast ceiling. The flight completed a right turn to a northeasterly heading and suddenly divided to the ground. People in the immediate vicinity reported that the aircraft was on fire before it crashed. The National Transportation Safety Board determines that the probable cause of this accident was one or more low-order explosions in the aft fuselage which resulted in a fire and loss of control capability. The Safety Board could not determine conclusively the fuel and ignition sources of the initial explosion; however, gases from the aircraft batteries or fuel leakage from fuel system components, or both, could have been present in the area of the initial explosion.

24124 Current status of the hollow fiber sodium-sulfur cell. Tsang, F.Y.; Anand, J.; Levine, C.A. (Dow Chemical, Walnut Creek, CA). pp 12-14 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The Dow Na/S cell is described, as well as its characteristics with respect to possible applications. The performance of 0.5- and 5-Ah research cells is discussed; one of the former lasted 384 days, and underwent 9068 cycles at 29% depth of discharge. Four failure modes were identified, and corrective steps are being taken. Estimated battery cost is in the range of $25 to $30 per kWh. 2 figures, 2 tables. (RWR)

24125 Characteristics of the aluminium-lithium/iron sulfide cells in immobilised salt electrolytes. Birt, D.; Feltham, C.; Hazzard, G.; Pearce, L. (Admiralty Marine Tech. Establishment, Poole, England). pp 14-16 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Exploratory experiments with small secondary cells employing immobilized salt electrolytes and electrodes prepared by powder compaction processes are described. V-t characteristics are shown for Li-Al/LiCl-KCl/FeS_2, Li-Al/LiCl-KCl/FeS, and Li-Al/LiF-LiCl-LiBr/FeS cells. Cells typically performed for several hundreds of cycles at current densities of 25 mA/cm^2. The power density of the present cell is limited by the anode. At the 5 to 10 h rate the estimated energy density based on 10-kWh modules is 130 Wh/kg. Because of the small quantities of electrolyte, relatively large changes in the amount and composition of the electrolyte can occur rapidly; freezing out of LiCl-KCl can result. Use of an all-lithium halide ternary electrolyte can overcome this problem. 4 figures. (RWR)

24126 Characterization of aged unactivated thermal battery components. Wong, P.; McCauley, J.W. (Army Materials and Mechanics Research Center, Watertown, MA). pp 69-72 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Routine surveillance discharge tests of stored cup and cover design thermal batteries from identical lots have indicated the statistical probability of marginal and unacceptable performance. This study consisted of selecting and dissecting random, undischarged batteries from statistically poor lots. Routine nondestructive tests were carried out on the batteries themselves, and these were followed by dissection of the unactivated batteries and detailed characterization of the active components. Progressive degradation of the calcium anode was found to have occurred. The hydrolyzation process, occurring on the surface of the anode, apparently took place in the absence of leaks and in the atmosphere present in the battery. The presence of a thin poly(vinyl acetate) coating on the surface of some anodes was noted; such a coating presents an abnormal condition. Manufacturer's quality control as well as deterioration of components was evaluated as the origins of the unacceptable battery performance. 3 figures, 4 tables. (RWR)

24127 Thermal battery improvements. DeGruson, J.A. (Eagle-Picher, Industries, Inc., Joplin, MO). pp 79-81 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Research on the $Ca/CaCrO_4$ and $Li-Al/FeS_2$ systems is reported. Performance (voltage vs time/of the latter is presented at 20, 500, and 600°C and for different percentages of silica in the electrolyte (KCl-LiCl eutectic). An energy density of 16.5 Wh/kg was obtained; 50 Wh/kg is anticipated. 4 figures, 1 table. (RWR)

24128 Low temperature thermal battery: the $LiAl/NaAlCl_4/MoCl_5$ system. Ryan, D.M. (Eureka Co., Bloomington, IL); Marsh, R.A.; Bunting, R.K. pp 90-92 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

A low-temperature (~ 200°C) thermal battery is being developed. Materials used and cell and battery fabrication are described, and the results are presented and discussed. Plots of energy density vs current density, current density vs cell life, potential vs time, and peak voltage vs current density are given. High single-cell voltage and noise-free discharge curves are demonstrated. 6 figures. (RWR)

24129 Evaluation of zinc/silver chloride batteries after 10 years storage. Fryer, A.J.; Morgan, C.J.; Sinclair, T.J. (Royal Armament Research and Development Establishment, Sevenoaks, England). pp 101-106 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The battery studied had specifications that included a shelf life of 5 to 10 years, storage and operational temperature ranges of 233 to 343 and 241 to 323 K, and leakproof operation for up to 180 days in any orientation. The effects of 10 years' storage on electrical and physical characteristics of the batteries are discussed. Open-circuit and on-load voltages and discharge curves are plotted; scanning electron photomicrographs of the electrodes are shown. The main design requirements of the batteries were fulfilled. 7 figures, 3 tables. (RWR)

24130 Five year storage tests of solid state Ag/I_2 batteries. Warburton, D.L. (Naval Surface Weapons Center, Silver Spring, MD); Bis, R.F.; Owens, B.B. pp 106-109 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Approximately 280 solid-state $Ag/RbAg_4I_5/I_2$ batteries were fabricated for this program. These tests were performed to confirm mode and rate of battery degradation. Variation of battery resistance with storage temperatures and time and battery voltage as a function of current density and discharge temperature are plotted. Battery capacity and microcalorimetric output after storage are tabulated. Batteries were still functional after five years of storage. The principal mode of failure was due to diffusion of I_2 from the cathode. 4 figures, 4 tables. (RWR)

24131 Failure analysis of cells in an accelerated test program. McDermott, P.P. (Coppin State Coll., Baltimore, MD). pp 109-113 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Test results on some 6-Ah Ni/Cd cells subjected to accelerated testing are evaluated. A model for cell degradation and failure is described. The failure of these cells is related to corrosion of the Ni sinter, the corresponding increase in charged Cd in the negative electrode, the expansion of the positive plate, and the drying out of the separation. 3 figures, 2 tables. (RWR)

24132 INTELSAT IV Ni-Cd battery orbital performance. Dunlop, J.D. (COMSAT Labs., Clarksburg, MD); Earl, M.W.; Weber, F.W.; Cooper, D.B. pp 113-117 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The performance of the batteries on the F-2 satellite through 14 eclipse seasons and of those on F-3 and F-4 satellites during 12 eclipse seasons is described. Battery characteristics and operation are discussed, including voltages, current loads, and reconditioning. The Ni/Cd batteries became a problem after about six years on the spacecraft, as the load that they could support began to drop significantly. Improvements in battery technology brought about by this program are noted. 5 figures, 4 tables. (RWR)

24133 Considerations of capacity increases in sintered plate nickel oxide electrodes. Seiger, H.N. (Yardney Electric Corp., Pawcatuck, CT). pp 120-123 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The capacity of battery cells having sintered-plate nickel oxide electrodes sometimes increases with use. Electrochemical processes that could be responsible for this phenomenon are discussed, e.g., corrosion of the sintered and formation of unformed material. These considerations give rise to a series of relationships that may constitute diagnostic tests for the processes involved in the capacity increase. 1 table. (RWR)

24134 Performance of nickel-cadmium satellite cells having new electrochemically impregnated, sintered electrodes. Harkness, J.D. (Naval Weapons Support Center, Crane, IN); Pickett, D.F.; Wang, J.C. pp 123-126 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Thirty-five 50-Ah cells with electrochemically impregnated electrodes were tested. Polypropylene or nylon separators were used. Test procedures and results are discussed, and reasons for failures are examined. Best overall cycle life was obtained from a battery that was not reconditioned. Conclusions drawn from the study are summarized. 6 tables. (RWR)

24135 Improvement and cycle testing of Ni/H_2 cells. Holleck, G.L.; Turchan, M.J.; DeBiccari, D. (EIC Corp., Newton, MA). pp 139-141 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Cells with various stack configurations, using a variety of different stack components, were evaluated in an accelerated synchronous-orbit cycle regime. Characteristic voltage, pressure, and temperature changes during a three-hour test cycle are shown; detailed measurements for individual cells are presented for cycle 96 and cycle 1500. Self-discharge parameters for 14-Ah cells are also tabulated. It is shown that continuous changes in capacity, cell voltage, and other parameters do take place. 1 figure, 5 tables. (RWR)

24136 Performance characteristics of iron nickel batteries. Hill, F.E.; Rosey, R.; Vaill, R.E. (Westinghouse Electric Corp., Pittsburgh, PA). pp 149-152 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Graphs of capacity, power characteristics, and typical life tests of previously developed type E-180 180-Ah cells are shown. Improved characteristics of a 109-kWh, 132-V dc battery used in mining operations are reviewed. An advanced Fe/Ni battery should provide a road vehicle with a range of 100 miles at 50 MPH. 6 figures, 2 tables. (RWR)

24137 Development of nickel-zinc batteries for aircraft, remotely piloted vehicle and missile applications. Brown, R.A. (Eagle-Picher Industries, Inc., Joplin, MO); Erisman, L.R.; Bishop, W.S. pp 157-160 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The performance of batteries developed for each of these three applications is summarized. It is concluded that the Ni/Zn battery has excellent high-rate, low-temperature performance for aircraft applications, with reasonable cycle life (200 cycles). Ni/Zn batteries for remotely piloted vehicles were compared with similar Ag/Zn and lead-acid batteries; testing is not yet complete; but results similar to those for the aircraft battery are expected. The performance of Ni/Zn and Ag/Zn missile batteries at 24°C is shown. The Ni/Zn battery performed better at elevated temperatures, but not at low temperatures. Both types of batteries would require heaters. It was felt that the Ni/Zn battery is a viable alternative to the Ag/Zn, especially for applications involving long wet stand. 6 figures. (RWR)

24138 Silver-iron battery performance characteristics. Buzzelli, E.S. (Westinghouse Electric Corp., Pittsburgh, PA). pp 160-162 of Twenty eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The Ag/Fe battery was developed to provide high energy content with long service life. The electrochemistry involved is discussed briefly, and then cell design, cell performance, and battery performance are considered. Charge-discharge and capacity maintenance characteristics are shown. 4 figures, 1 table. (RWR)

24139 Long-term storage effects on sealed Ag-Zn cells. Lear, J.W.; Imamura, M.S. (Martin Marietta Corp., Denver, CO). pp 165-167 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

An abbreviated test program was performed on ESB sealed Ag-Zn cells that had been stored for over 10 years in a discharged state at 25°C. The results showed that the polypropylene separator used in the cells was effective in preventing electrode shorts over a storage period of more than 10 years, and that the stored cells were capable of achieving over 100 cycles at 40% DOD. 4 figures, 2 tables.

24140 Field tests with lithium/SO_2 batteries. Tuvnes, B. (Norwegian Army Materiel Command, Oslo). pp 176-178 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Tests of Li/SO_2 dry batteries for use in cold conditions are reported. Experiments included measurements of hours of service, performance as a function of temperature, and storability of cells of various sizes. The Li/SO_2 batteries were found to be very reliable under all environmental conditions with a very low failure rate, and are much more suitable than earlier batteries (long-term (3-y) storability is better than that of Zn/C batteries and much better than that of Ni/Cd). 5 figures. (RWR)

24141 Li/SO_2 cells of improved stability. Taylor, H. (P.R. Mallory and Co., Inc., Burlington, MA); Bowden, W.; Barrella, J. pp 183-188 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

To clarify reasons for venting and burning of Li/SO_2 cells upon cell reversal, the authors examined cell chemistry and electrochemistry in some detail, particularly for conditions of voltage reversal. Normal discharge conditions, cathode behavior on reversal, anode behavior on reversal, discharge products produced on reversal, and thermal stability of reaction products are discussed; the chemistry of cells in reversal is summarized. Then results on the behavior of standard commercial cells in reversal are presented and compared with those of cells modified by reducing the amount of lithium present. The latter operated much less hazardously on reversal. 6 figures, 1 table. (RWR)

24142 Analysis of Li/SO_2 system safety. Shah, P.M. (Honeywell Power Sources Center, Horsham, PA). pp 188-191 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

A family of multicell Li/SO_2 reserve batteries was being developed. After prolonged discharge batteries were examined, several exploded. Unique features of these particular cells, potential causes of the explosive conditions, and present research efforts are discussed. 2 figures, 1 table. (RWR)

24143 Chemistry of the Li/SO_2 battery: a review. Kilroy, W.P. (Naval Surface Weapons Center, Silver Spring, MD). pp 198-202 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The chemistry and electrochemistry of the Li/SO_2 battery are reviewed, in particular with respect to the stability of the system. Reactions of the electrolyte, reactions of lithium (at the Li surface, with the cathode collector, and with the electrolyte), and reactions of SO_2 (chemical reactions, electrochemical and chemical reductions) are discussed. The possible reactions taking place in a Li/SO_2 cell are quite complex. 5 tables. (RWR)

24144 Applications of the lithium/carbon mono-fluoride battery. Higgins, R.L.; Erisman, L.R. (Eagle-Picher Industries, Joplin, MO). pp 208-210 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

General characteristics of Li/polycarbon monofluoride cells are summarized, including results of abuse tests. Pictures are shown of 600-mAh button cells, a 5-Ah high-temperature battery, and a 25-Ah battery; voltage vs time plots are presented for each type. 6 figures. (RWR)

24145 Lithium-manganese dioxide cell. Ikeda, H.; Hara, M.; Narukawa, S. (Sanyo Electric Co., Ltd., Kobe, Japan). pp 210-213 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The discharge mechanism of the Li-MnO_2 cell was investigated. The cell reaction in nonaqueous electrolyte is given as Li + MnO_2(IV) → MnO_2(III)(Li^+), where the Li^+ is introduced into the MnO_2 crystal lattice. Structures and specifications are given for flat, layered, and cylindrical cells. Discharge characteristics are plotted for various types; effects of temperature and storage are shown. Features of the cell leading to expected wide use are noted. 11 figures, 3 tables. (RWR)

24146 Corrosion: a major failure mode of Li/V_2O_5 cells. Ebner, W.B.; Merz, W.C. (Honeywell Power Sources Center, Horsham, PA). pp 214-219 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

It has been believed that cell corrosion was caused by one or more of the cell reaction products. This model was found to be incorrect. Potentiodynamic anodic polarization scans demonstrated that trace quantities of ionic chlorides can induce massive corrosion of 316L stainless steel in 2M $LiAsF_6$ + 0.4M $LiBF_4$/methyl formate electrolyte solutions. The maximum tolerable chloride concentration was found to lie between 100 and 200 ppM. Both oxygen and ionic nitrates were shown to be capable of completely inhibiting chloride-induced corrosion of 316L stainless steel in these solutions. The addition of nitrate appears particularly attractive as a corrosion inhibitor in Li/V_2O_5 cells because of its efficiency and because its concentration can be easily controlled; however, its effect on cell performance must be evaluated before it can be recommended for use. 8 figures, 3 tables. (RWR)

24147 Properties of the LiCuO couple. Jumel, Y. (SAFT Leclanche, Poitiers, France); Broussely, M.; Thunder, A.; Allvey, G.W. pp 222-226 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Development work on 1.5-V AA size cells with a nonwoven glass fiber separator was undertaken. A number of performance and abuse tests were performed, and the results are presented. Effects of temperature, storage, and discharge regime are noted. 4 figures, 6 tables. (RWR)

24148 Use of microcalorimetry in characterization of lithium pacemaker batteries. Holmes, C.F.; Holmes, W.S.; McLean, R.L.; Greatbatch, W. (Wilson Greatbatch Ltd., Clarence, NY). pp 226-229 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

An overview of microcalorimetry as used in battery investigations and results of measurements of heat evolution in lithium/iodine polyvinyl pyridine pacemaker batteries are presented. The microcalorimeter was sensitive to less than 1 μ W. Its use is illustrated in distinguishing innocuous chemical reactions from self-discharge, characterizing prototype cells, helping to understand self-discharge mechanisms, and testing suspected failures for internal shorts. 4 figures, 1 table. (RWR)

24149 Li/$SOCl_2$ cell as an effective power source. Morley, D.; Solar, R.J. (Arco Medical Products, Leechburg, PA). pp 232-236 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Cell construction is briefly described, and then a number of tests to ensure safety and reliability of Li/$SOCl_2$ pacemaker batteries are discussed. The tests include the following: self-discharge measurements, capacity tests, measurements of high- and low-drain battery impedances, pressure and short circuit tests, and checks of hermetic seals and corrosion resistance. Some results are presented. 4 figures, 4 tables. (RWR)

24150 Performance characteristics of large primary Li/$SOCl_2$ cells. Marincic, N.; Goebel, F. (GTE Sylvania, Needham, MA). pp 244-246 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Early performance data obtained with large-capacity cells (2000 and 10,000 Ah) are presented, along with performance data for series and series-parallel arrangements simulating intended uses. Discharge characteristics for 2000-Ah cells are shown; current, voltage, temperature, and pressure were monitored as a function of time for discharges at 200 A (initially). 5 figures. (RWR)

24151 Large lithium-thionyl chloride cells: cell performance and safety. Chua, D.I.; Crabb, J.O.; Deshpande, S.L. (Honeywell Power

Sources Center, Horsham, PA). pp 247-251 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The effect on cell performance of two cell design approaches aimed at minimizing the safety problem (pressure buildup during discharge and thermal runaway) and improving cell reliability is presented; the approaches are anode-limited cells and thick electrodes. Also shown are data on internal cell pressure and temperature characteristics. Cells with capacities ranging from 1.6 to 11,000 Ah were used. An anode-limited design was found to be a viable approach for $Li/SOCl_2$ cells from aspects of storage, discharge, passivation, and safety. 7 figures, 2 tables. (RWR)

24152 Primary $Li/SOCl_2$ cells. VI. Identification of the possible explosion causing cell constituents by DTA studies. Dey, A.N. (P.R. Mallory and Co. Inc., Burlington, MA). pp 251-255 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Investigations of the spontaneous reactivity of cell constituents by the use of differential thermal analysis are described. It was demonstrated that there are several constituents in the $Li/SOCl_2$ cell that could create a thermal runaway when heated to a suitable temperature, Li being the most important. The presence of excess Li in the cell may be quite safe as long as the cell temperature remains below the melting point of S. It was shown from exothermicity measurements that there are several chemical combinations that may be present in a partially discharged $Li/SOCl_2$ that cells are capable of undergoing spontaneous exothermic reaction to produce heat inside the cell. Moisture accelerated this heat generation. Thus, a safer cell design requires a total hermetic cell enclosure to prevent entrance of moisture. 6 figures, 1 table. (RWR)

24153 Safety aspects of $Li/SOCl_2$ batteries. Abraham, K.M.; Gudrais, P.G.; Holleck, G.L.; Brummer, S.B. (EIC Corp., Newton, MA). pp 255-257 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

A phenomenological study of the explosion hazard of $Li/SOCl_2$ cells on forced overdischarge is presented. Both cathode-limited and anode-limited cells were studied. Galvanostatic discharge and overdischarge plots show potential as a function of time. It is concluded that cathode-limited cells appear safe while anode-limited cells are hazardous and may explode without warning; the negative-limited cells appear not to be the answer to the safety problem of $Li/SOCl_2$ cells. 3 figures. (RWR)

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 24114, 24118, 24121, 24122, 24133, 24134, 24139, 24172, 24428, 24435, 24498

24154 System and method for charging electrochemical cells in series. DeLuca, W.H.; Hornstra, F. Jr.; Gelb, G.H.; Berman, B.; Moede, L.W. US Patent Application 009,622. [nd]. 20p.

A battery charging system capable of equalizing the charge given each individual cell at a selected full charge voltage includes means for regulating charger current to increase current at a constant rate until a bulk charging level is achieved or until any cell reaches a safe reference voltage. A system controller then begins to decrease the charging rate as long as any cell exceeds the reference voltage until an equalization current level is reached. At this point, the system controller activates a plurality of shunt modules to permit shunting of current around any cell having a voltage exceeding the reference voltage. Leads extending between the battery of cells and shunt modules are time shared to permit alternate shunting of current and voltage monitoring without the voltage drop caused by the shunt current. After each cell has at one time exceeded the reference voltage, the charging current is terminated.

24155 (ANL—80-16) Conceptual design of electrical balance of plant for advanced battery energy storage facility. Annual report, March 1979. (United Technologies Corp., South Windsor, CT (USA). Power Systems Div.). Jan 1980. Contract W-31-109-ENG-38. 137p. NTIS, PC A07/MF A01.

Large-scale efforts are in progress to develop advanced batteries for utility energy storage systems. Realization of the full benefits available from those systems requires development, not only of the batteries themselves, but also the ac/dc power converter, the bulk power interconnecting equipment, and the peripheral electric balance of plant equipment that integrate the battery/converter into a properly controlled and protected energy system. This study addresses these overall system aspects; although tailored to a 20-MW, 100-MWh lithium/sulfide battery system, the technology and concepts are applicable to any battery energy storage system. 42 figures, 14 tables. (RWR)

24156 (ANL—80-30) Analysis of an internally pressurized prismatic cell can. Majumdar, S. (Argonne National Lab., IL (USA)). Apr 1980. Contract W-31-109-ENG-38. 62p. NTIS, PC A04/MF A01.

This report contains an elastic stress and displacement analysis of a prismatic cell can subjected to internal pressure. A computer program was written to perform the analysis. The results show that, for the geometry chosen, the thicknesses of the cell-can walls and the magnitude of the internal pressure are the most important parameters that determine the stresses and deformations of the cell can. Recommendations for future studies are included. 21 figures, 1 table.

24157 Voltage regulator for battery power source. Black, J.M. US Patent 4,151,456. 24 Apr 1979. Filed date 9 Mar 1978. 5p.

A bipolar transistor in series with the battery as the control element also in series with a zener diode and a resistor is used to maintain a predetermined voltage until the battery voltage decays to very nearly the predetermined voltage. A field effect transistor between the base of the bipolar transistor and a junction between the zener diode and resistor regulates base current of the bipolar transistor, thereby regulating the conductivity of the bipolar transistor for control of the output voltage.

24158 NASICON: a new solid electrolyte for Na/S batteries. Kafalas, J.A.; Hong, H.Y.P. (Massachusetts Inst. of Tech., Lexington). pp 1-2 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

NASICON (NA SuperIonic CONductor) has the composition $Na_3Zr_2\ Si_2PO_{12}$. The development of techniques for the fabrication of specimens with essentially theoretical density and the initial results of stability tests of such specimens in Na/S cells are reported. The resistivity of NASICON compares favorably with that of β''-alumina. Advantages of NASICON over β-alumina are noted. (RWR)

24159 Structure of the sulfur electrode in sodium-sulfur cells and comparison with model predictions. Breiter, M.W.; Dunn, B. (General Electric Co., Schenectady, NY). pp 4-7 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Experimental studies and theoretical considerations are presented for a new sulfur electrode design that consistently permits Na/S cells to be charged into the two-phase region. The results of a rechargeability model based on the spatial distribution of carbon mat and polysulfide potentials within the electrode are given. Experimental evidence favors this approach over an alternate one involving mass transport of reactants and products. The potential distribution for the sulfur electrode with graduated resistance is discussed. Reaction rate distributions for dual and single mat geometries are shown for three values of mat resistance. 5 figures. (RWR)

24160 Sodium-sulfur battery: a progress report. Topouzian, A. (Ford Motor Co., Dearborn, MI); Harlow, R.A. pp 7-11 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The status of work on the development of a 1-MW load-leveling battery is summarized. Emphasis was on the evaluation of sulfur container materials and coatings as actual hardware for exploratory cells. Results of performance testing of several types of cells are given; corrosion was a big factor in limiting service life. Safety tests demonstrated the effectiveness of using a steel tube inside the electrolyte to limit the amount of sodium near the electrolyte, to prevent a catastrophic reaction in case of internal cell failure. A description of recently constructed test facilities is given. Na/S cells continue to show potential. 10 figures, 5 tables. (RWR)

24161 Lithium-boron alloy: a new battery anode material. Larrick, B.F. (Naval Surface Weapons Center, Silver Spring, MD); James, S.D.; Szwarc, R. pp 95-98 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

This alloy, which may prove useful in both low-temperature and molten-salt lithium batteries, can be described as a refractory metalloid with the electrochemical behavior of Li that has the properties of a solid even at elevated temperatures. The feasibility of its use in primary thermally activated molten-salt cells was investigated. Alloy preparation and properties, anode and cell fabrication,

and single-cell-discharges are described. Two inflections were noted in the potential vs time curves. The temperature dependence of discharge potentials and Coulombic efficiencies of anode-limited molten salt cells are also shown. It was found that this alloy has up to twice the discharge capacity of other commonly used anodes, and can be usefully discharged at efficiencies approaching 100%. Useful temperature range is 400 to 600°C. Estimated specific energy is approximately 85 Wh/kg. 4 figures, 1 table. (RWR)

24162 Latex bonded lead dioxide reserve electrode. Paulson, J.W. (ESB Inc., Madison, WI). pp 99-101 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Electrode formulation and processing, the discharge test cell configuration, and test results are discussed. Discharge capacity under various storage temperature conditions and shelf-life decay rate constants and Coulombic efficiencies are tabulated. These cathodes showed good shelf-life characteristics, and adhesion of the bonded cathode to the substrate was very good. 3 figures, 2 tables. (RWR)

24163 BEST Facility: accelerating the development of utility load-leveling batteries. Lewis, P.A.; Pivec, A. (PSE and G Research Corp., Newark, NJ). pp 131-135 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The Battery Energy Storage Test Facility for testing advanced battery and power conversion systems, for near-term use in load leveling by electric utilities, is described. Design criteria, location, substation interconnection, ac-dc converter, control, data acquisition and communications, and data analysis and reporting are discussed. The status of the project is summarized. 6 figures. (RWR)

24164 $LaNi_5$ electrodes in nickel-hydrogen batteries. Markin, T.L.; Bridger, N.J.; Bennett, R.; Dell, R.M. (Atomic Energy Research Establishment, Harwell, England). pp 136-138 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Build-up of H_2 pressure and heat balance in satellite systems may be improved by use of a $LaNi_5$ negative electrode. Preparation and performance of small and large electrodes are described; plots of voltage vs time and capacity vs cycle number are shown up to cycle 947. Potential and pressure are plotted vs time for fully immersed and non-immersed 8-Ah cell stacks for representative cycles. Work on gas recombination is briefly discussed. It is concluded that a $LaNi_5$ electrode allowing at least 1000 charge/discharge cycles without disintegration can be fabricated, and that the electrode will maintain its capacity as long as it is adequately protected against oxygen transfer toward the end of charge and during overcharge. Capacity reaches 240 mAh/g. 6 figures. (RWR)

24165 Transition metal sulfide-lithium organic electrolyte rechargeable cells. Eisenberg, M. (Electrochimica Corp., Mountain View, CA). pp 155-157 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The sulfospinels appear to be a promising group of new cathode materials for high-energy lithium cells. Their reversible discharge is likely to be by an interstitial migration of lithium into the face-centered cubic structure. So far, the most interesting results have been obtained with $CuCo_2S_4$, for which energy storage efficiency of the order of 79% is indicated. These materials are also capable of operation in molten salt electrolytes and probably with certain solid electrolytes as well. 3 tables.

24166 Heat and chemically resistant membranes. Angres, I.A.; Duffy, J.V.; Kilroy, W.P. (White Oak Lab., Silver Spring, MD). pp 162-164 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The preparation of new, heat-resistant separators for alkaline batteries (AgO/Zn, Ni/Zn), based on blends containing polyphenylquinoxaline (PPQ), an aromatic polymer, as the matrix is described. Polymers used with PPQ were polyvinylpyrrolidone, cellulose acetate, cellulose triacetate, or polyvinylacetate. Resistance and thickness of membranes are tabulated. Dimensional and weight changes vs exposure time, rate of achieving constant resistance, and diffusion of OH-through membranes are plotted. 5 figures, 1 table. (RWR)

24167 Substitutes for mercury in alkaline zinc batteries (II). Himey, A. (Navy Dept., Washington, DC); Wagner, O.C. pp 167-169 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Attempts were made to find a safer substitute for Hg in Ag/Zn batteries. Work was done on cells of 2.5 and 850 Ah. Addition of two of the following elements: Cd, Pb, In, Tl - to the Zn electrode active material resulted in cells that were superior to those using Hg. Two of the improvements were better cycling capability and higher discharge voltage. 4 figures, 1 table. (RWR)

24168 Effects of the electrochemical design upon the safety and performance of the lithium-sulfur dioxide cells. DiMasi, G.J.; Christopulos, J.A. (ERADCOM, Fort Monmouth, NJ). pp 179-182 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Previous studies have shown that the electrochemical balance between the anodic and cathodic reactant affects the performance of the cell with respect to safety when it is overdischarged. The present investigation studied the effects of lithium/sulfur dioxide ratio, carbon content, rate of discharge, prior storage, and temperature. Cell capacities ranged from 2 to 9 Ah. Voltage is plotted vs time for cells subjected to various conditions. The most significant variable in designing a cell capable of operating safely at high rates (5A) was found to be the Li/SO_2 ratio, which should be between 0.9 and 1.0. 6 figures, 2 tables. (RWR)

24169 Stability of the $LiAsF_6$:An:SO_2 electrolyte. Shah, P.M.; Eppley, W.J. (Honeywell Power Sources Center, Horsham, PA). pp 195-198 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Various storage/discharge tests conducted on this electrolyte for Li/SO_2 active cells are summarized. The performance of cells using electrolyte stored under various conditions was investigated; these included storage in glass ampuls, storage in stainless steel activators, active cell storage, and storage with long-term discharge. Cell performance for discharge under intercell leakage conditions was also investigated. It was found that this electrolyte has exceptional stability. It was virtually unaffected by storage container or method of discharge. Losses due to self-discharge or other side reactions were negligible. 6 figures, 1 table. (RWR)

24170 Passivating layer on lithium in lithium tetrachloroaluminate-$SOCl_2$ solutions. Peled, E.; Yamin, H. (Tel Aviv Univ., Israel). pp 237-241 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

SEM results on Li exposed to $LiAlCl_4$-$SOCl_2$ solutions for various times are shown. Galvanostatic measurements of the resistivity and thickness of the solid electrolyte interphase (SEI) are plotted. Deposition of the SEI crystals is discussed. 10 figures. (RWR)

24171 Thionyl chloride electrolytes containing $B_{10}Cl_{10}^{--}$ and $B^{12}Cl_{12}^{--}$. Schlaikjer, C.R. (GTE Labs., Inc., Waltham, MA). pp 241-244 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

$Li_2B_{10}Cl_{10}$ and $Li_2B_{12}Cl_{12}$ were prepared and the conductivity of these materials in thionyl chloride was measured. Results are plotted as a function of concentration and temperature. Chemical reactions taking place in the solutions are discussed. Eight cells containing $Li_2B_{10}Cl_{10}$ discharged at rates up to 700 mA(2.61 mA cm^{-2}) gave an average of 13.4 Ah. 5 figures. (RWR)

APPLICATIONS

REFER ALSO TO CITATION(S) 23851, 24345, 24348

24172 Batteries for auxiliary electrical supplies in aircraft. Doran, R.J.; Attewell, A.; Pomroy, S.E.A.; Tattershall, P.; Thompson, J. (Royal Aircraft Establishment, Farnborough, England). pp 66-68 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The scope for batteries in aircraft is considered. Factors to be taken into account in the choice of battery systems are enumerated; the energy/power characteristics of some current battery systems are plotted. The profound effects that a simple variation in maintenance procedures can have on the performance of a typical aircraft

battery are illustrated for the Ni/Cd system. 3 figures, 1 table. (RWR)

ENERGY MANAGEMENT AND POLICY

REFER ALSO TO CITATION(S) 24332, 24333

24173 (DOE/PR—0038) **Department of Energy Procurement and Financial-Assistance Career Guide.** (Department of Energy, Washington, DC (USA)). May 1980. 30p. NTIS, PC A03/MF A01.

This guide supports the Procurement Career Management and Development Program which is administered by the Procurement Career Management and Development Board. Objectives are: (a). To meet current and future DOE-wide needs for procurement and financial-assistance people and to provide capable replacements for key procurement and financial-assistance positions on a planned, systematic basis. (b). To attract, select, develop and retain, on a long-term career basis, a higly qualified workforce capable of performing current and future DOE procurement and financial assistance functions. (c) To increase the proficiency of DOE procurement and financial-assistance people in their present positions and to give talented people opportunities for broadening experiences and progression commensurate with their abilities. (d) To stimulate self-development. The program applies to all procurement and financial-assistance people, or those who perform key related function, in DOE who are serving under career or career-conditional appointments in the competitive service.

24174 (DOE/S—0005(79)) **Energy management in the Federal Government.** (Federal Energy Management Program, Washington, DC (USA)). Dec 1979. 141p. NTIS, PC A07/MF A01.

Annual report to the President of the United States, fiscal year 1978.

A summary is presented of the performance of Federal departments and agencies in energy conservation since FY 1975, with special attention being given to 1978. The Federal energy conservation effort is monitored by DOE and involves the experience of 66 executive departments and agencies. The best available data are obtained from agency quarterly energy use reports, agency annual reports, and analyses prepared by DOE. Information in quarterly energy use reports received up to September 30, 1978, has been incorporated into this document. The agency annual reports are summarized in Appendix B and highlights are presented in Appendix A. These agency reports cover energy used in buildings, facilities, and vehicles that are owned and operated by each agency. Energy use in buildings, facilities, and vehicles owned and controlled by the GSA is included in the GSA report.

24175 (ORNL—5636) **Spatial data on energy, environmental, health, and socio-economic themes at Oak Ridge National Laboratory: 1979 inventory.** Copenhaver, E.D.; Barker, J.F. (eds.). (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 126p. Dep. NTIS, PC A07/MF A01.

Spatial data files at Oak Ridge National Laboratory addressing energy, environmental, health, and socio-economic themes are described. In order to be included in this inventory, data files must reside at ORNL, be numeric, have some spatial attribute, and have potential for exchange or external use. Most of the files described are available on a cost-recovery basis. The inventory is indexed by content, geographic coverage, and contact person. In addition, a short description of each data file is provided, including technical documentation, original data source, availability limitations, and associated software where pertinent.

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 24198, 24200, 24211, 24258, 24264

24176 (IKE-K—54-19) **Energy-industry-environment system of Baden-Wuerttemberg.** Hoecker, K.H. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme). Nov 1979. 20p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

Following some general remarks on the task and function of systems analyses in society, remarks are made on the description of development trends by models and on the goals of systems analysis. As an example for modelling, the development of the structure of space heating and hot-water consumpton in Baden-Wuerttemberg is described.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 23600, 24069, 24175, 24188, 24192, 24199, 24201, 24202, 24207, 24208, 24209, 24251, 24264, 24275, 24304, 24624, 24664

24177 (CONF-791178—) **Proceedings of the third workshop on the energy development board of Mercer County, North Dakota.** (Energy Development Board of Mercer County, Stanton, ND (USA)). Mar 1980. Contract EM-76-F-01-8154. 47p. Dep. NTIS, PC A03/MF A01.

From 3. workshop on the Energy Development Board of Mercer County of North Dakota; Bismarck, ND, USA (1 Nov 1979).

Two earlier workshops concerned with managing growth in Mercer County, North Dakota focused on the activities of the Energy Development Board (EDB) and were held in 1977 and 1978, respectively. This third workshop, Energy Development in Rural Areas - Local Implementation of National Priorities addresses the transferability of the EDB as an organization approach for managing energy-related rapid growth; the potential for developing integrated energy resource conservation/economic plans in rural energy development areas; and Federal policy and initiatives regarding energy-impact assistance. Panel discussions on these subjects were conducted and the comments are presented. The introductory address by Wayne Sanstead, Lt. Gov. of North Dakota and the keynote address by Edward Helminski, White House Management Task Force on Energy Shortages, are included.

24178 (PB—299729) **Jobs and power for Alaskans - a program for power and economic development.** (Alaska Dept. of Commerce and Economic Development, Juneau (USA)). Jul 1978. 103p. NTIS, PC A06/MF A01.

The report discusses a plan to increase employment in Alaska through the economic development of its natural resources to produce electric power. A profile of the Alaskan economy is presented. Development of natural resources for non-energy purposes is also discussed.

24179 (PB—299737) **Coping with energy limitations in transportation: proposals for Michigan.** Kaufman, R.; Koenig, H. (Michigan Univ., Ann Arbor (USA). Highway Safety Research Inst.). Apr 1979. 48p. NTIS, PC A03/MF A01.

The transportation energy dependence of Michigan's economy and major industries (auto manufacturing and tourism) is discussed and quantified. For the balance of this century, the real cost of energy will rise and its availability will decline. Net energy gains are expected to decline as well (the difference between the energy required to extract remaining supplies and the amount of energy supplies that are captured). Alternative energy forms and automotive propulsion systems are surveyed and assessed. Probable economic impacts on Michigan are discussed and the dual pressures of rising transport energy costs and federal regulations on the auto industry are outlined. State action for managing the economic transition which Michigan faces is recommended, and a mechanism for managing change is proposed.

24180 (PB—300758) **Crisis intervention programs in Federal Region III: a policy perspective.** Barnhouse, L.; Beachy, B.; Dodd, D.; Durham, L.; Ellyn, M. (Syracuse Research Corp., NY (USA). Energy Research Center). Aug 1979. 116p. NTIS, PC A06/MF A01.

This report outlines the programmatic histories of the four main emergency energy/crisis intervention programs that have been conducted by the Community Services Administration to alleviate the hardships of energy shortages on the poor and discusses the benefits and problems associated with past programs, giving recommendations for building on existing strengths to achieve more effective programs in the future.

24181 (PB—300873) **Automotive manufacturers' cost/revenue, financial and risk analysis: projected impact of automobile manufacturing on the plastics industry. Final report June 1977-July 1978.** Kaiser, R. (Aerospace (H. H.) Design Co., Inc., Bedford, MA (USA)). Aug 1979. Contract DOT-TSC-1333. 184p. NTIS, PC A09/MF A01.

The report is part of a study to update the historical and projected cost/revenue analysis of the U.S. domestic automobile manufacturers. It includes the evaluation of the historical and projected financial data to assess the corporate financial position of each manufacturer and the assessment of the extraordinary risks imposed on the manufacturers by Automotive Fuel Economy Standards. In particular, the report includes the effect of changes in the characteristics of the average U.S. automobile on the plastics industry.

24182 (PNL—2410(Rev.2)) **Analysis of federal incentives used to stimulate energy production: an executive summary.** Cone, B.W.; Brenchley, D.L.; Brix, V.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Feb 1980. Contract EY-76-C-06-1830. 13p. NTIS, PC A02/MF A01.

The purpose of this research was to analyze past and present federal incentives to production of various energy sources and thereby assist the Division of Conservation and Solar Applications, Department of Energy, in the study and recommendation of federal incentives for the development of solar energy. The research was divided into five parts: a survey of current thought about incentives for solar energy production; the theoretical approach to analyzing and characterizing incentives; a generic view of the energy incentive creating landscape for 1978; analysis of the major energy sources (nuclear, hydro, coal, electricity, oil, and gas) along their trajectories from exploration to waste management, including their costs in 1978 dollars; and insights into potential incentives for solar policy. Economic, political, organizational, and legal viewpoints were considered in formulating the typology of incentives. Eight types of incentives were identified.

24183 Urban subcenters: recent trends in urban spatial structure. Greene, D.L. (Oak Ridge National Lab., TN). *Growth and Change;* **11**: No. 1, 29-40(Jan 1980).

Results of an investigation of the existence and significance of employment concentrations outside the central business districts of large metropolitan areas are presented. Trends in the intrametropolitan location of employment during te 1960s and early 1970s are examined by using small-area data for two points in time. The spatial detail of the data is roughly equivalent to that of census tracts. While it is known that cities are becoming multinucleated, studies with sufficient spatial detail to permit observations on alterations in urban subcenters are virtually nonexistent. This study explores those trends. Results are presented as (1) a review of the existing theory of urban subcenters and description of data sources and problems, (2) an examination of patterns of metropolitan deconcentration using traditional density approaches, (3) an application of an index of noncentral concentration derived from Lorenz curves measuring noncentrally focused spatial concentration, (4) a cartographic analysis of absolute changes in employment levels over the period of record for each city to identify employment growth centers outside the city center, and (5) an analysis of employment subcenters - their composition and transition - as a tool in delineating the process by which subcenters develop. 6 figures, 4 tables. (SAC)

24184 Politics of energy. O'Keefe, B.J. (EG and G, Boston, MA). *Oak Ridge Natl. Lab. Rev.;* **12**: No. 4, 13-21(Fal 1979).

Bernard J. O'Keefe, president and board chairman of Edgerton Germeshausen, and Grier (EG & G), made several points in a speech concerning the problems of politics and the energy situation. He sees the problems of the nuclear power industry centered around politics and finances - not technology. The difficulties of financing a typical 1000-MW plant by the utilities are briefly discussed. He sees the problems of waste disposal no longer as a technical problem but as a political one. He suggests that a location for disposal should be chosen first and the technology worked out for that site. In the event that alternative sources of energy become meaningful in the overall energy picture, the formidable question of backup energy supplies with their high fixed costs will add another dimension to the economic impact of the alternate sources. Mr. O'Keefe stated that the new energy sources would be expensive, that the public would resist those costs, and the politicians who face the problems squarely will be voted out of office. (SAC)

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 23757, 24175, 24663

24185 (PB—300358) **Applications of computer graphics to integrated environmental assessments of energy systems. Milestone report 1976-77.** Babb, M.C.; Hickey, H.R. Jr. (Tennessee Valley Authority, Chattanooga (USA). Div. of Environmental Planning). Aug 1978. 154p. NTIS, PC A08/MF A01.

This report summarizes the first two years of research designed to demonstrate applications of computer graphics to environmental analyses associated with the evaluation of impacts from development of conventional energy systems. The work emphasizes the use of storage-tube computer graphics technology as a means for improving the interaction between the engineer-scientist and the power of the computer. Computer graphics is also shown to be an effective medium for summarizing and communicating information about the environment and pollution control alternatives to technical specialists, managers, and the public. Also, many techniques of analysis previously considered impractical can now be conducted on a routine basis. Applications to several fields of analysis are described in detail, including air quality, water quality, radiological hygiene, industrial hygiene, socioeconomics, and data facilities siting with the use of geographically referenced data.

24186 (UCRL—15226) **Formal analysis including value judgments and public risk.** Keeney, R.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Apr 1980. Contract W-7405-ENG-48. 24p. Dep. NTIS, PC A02/MF A01.

Many government decisions have an impact on physical risks to the public. These decisions include setting of standards and regulations, licensing of various activities and goods, and allocation of financial resources. In all of these cases, one crucial element in the decision making process is that the expenditure of additional finances can reduce public risk (i.e., save lives and reduce injury and morbidity). The issue, which requires value judgements to solve, is to find the correct balance of expenditures and risks. Unfortunately, many of these important decisions are arrived at through informal decision processes. This paper describes an alternative formal procedure to focus explicitly on some of the value judgments necessarily used in these processes. A prototypical case of the Nuclear Regulatory Commission is examined to illustrte the concepts.

NATURAL RESOURCES

REFER ALSO TO CITATION(S) 23567, 24209, 24319

RESEARCH, DEVELOPMENT, DEMONSTRATION, AND COMMERCIALIZATION

REFER ALSO TO CITATION(S) 24200

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 23712, 23728, 24080

24187 (CONF-791103—110) **Neutron and fuel cycle kinetics analogy.** Maudlin, P.J.; Ott, K.O. (Oak Ridge National Lab., TN (USA); Purdue Univ., Lafayette, IN (USA). School of Nuclear Engineering). 1979. Contract W-7405-ENG-26. 7p. NTIS, PC A02/MF A01.

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

An analogy between neutron kinetics and fuel cycle kinetics has been exploited to produce an elegant and accurate point reactor population model. This model can be readily applied for unconstrained fuel logistic and reactor scenario strategy studies, with trivial computational effort. Furthermore, this point kinetics model can form the basis for realistic scenario simulation by including energy demand and economic constraints.

24188 Socio-economic impacts of nuclear power plants. Krause, C. *Oak Ridge Natl. Lab. Rev.;* **12**: No. 4, 36-45(Fal 1979).

Social scientists at the Oak Ridge National Laboratory, pioneered the field of analyzing the social and economic impacts of nuclear power plants on communities. The first study concerned Mendocino, California, where a large nuclear power plant was being considered. Because of the the scant information available for the first social impact assessment of a nuclear power plant, post-licensing studies of the socio-economic effects of operating reactors was initiated by ORNL social scientists at Plymouth, Massachusetts, site of the Pilgrim reactor, and Waterford, Connecticut, site of the Millstone I and II reactors. The three-pronged method used to ascertain socio-economic impacts on these nuclear communities consisted of interviews with local leaders and officials, and reliance on secondary data, including statistics on local population, school enrollment, and employment. Other studies discussed in this article include communities in Brunswick County, North Carolina, (Brunswick I and II) and Appling County, Georgia, (Hatch I and II). Mitigation plans to alleviate adverse impacts from nuclear power plant construction on communities are one of the results of this type of study. Mitigation plans for the Hartsville, Tennessee, project and the Cherokee Nuclear Station now under construction near Gaffney, South Carolina, are discussed. (SAC)

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 23543, 23545, 23546, 23547, 23548, 23549, 23550, 23551, 23552, 23553, 23554, 23555, 23556, 23557, 24267, 24268, 24269, 24270, 24271

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 24101, 24305, 24306, 24308, 24322, 24323, 24324, 24325

24189 (CONF-7910156—2) **Feasibility of a large district heating-cogeneration system for the Minneapolis-St. Paul area.** Jaehne, H.; Karnitz, M.A.; Rubin, A.; Margen, P. (Northern States Power Co., Minneapolis, MN (USA); Oak Ridge National Lab., TN (USA); Department of Energy, Washington, DC (USA); Studsvik Energiteknik AB, Nykoeping (Sweden)). 1979. Contract W-7405-ENG-26. 18p. NTIS, PC A02/MF A01.

From US/USSR technical exchange and symposium in the areas of heat rejection systems, cogeneration and beneficial uses of waste heat; Washington, DC, USA (15 Oct 1979).

The Department of Energy, Minnesota Energy Agency, Northern States Power Company, and other local government and private organizations are cooperatively performing an in-depth application study to determine the feasibility of district heating for a large northern US city. A Swedish firm, Studsvik, has developed an overall scenario and has attempted to show the potential of a fully implemented system. The proposed system would be about 2600 MW(t) and cover a significant portion of both Minneapolis and St. Paul. This study has proceeded in parallel with more in-depth studies of particular issues, such as detailed piping network plans in central St. Paul and cogeneration plant conversion cost study - both sponsored by Northern States Power Company. The overall conclusions that can be drawn at the present time are: (1) the concept is technically feasible; (2) it has great value from the fuel conservation aspect; and (3) the economics are viable with an appropriate financing system.

CONSERVATION

REFER ALSO TO CITATION(S) 24199, 24246, 24256, 24263, 24284, 24289, 24290, 24299, 24300, 24319, 24321, 24329, 24330

24190 (DOE/CS—0162) **Federal energy conservation programs pursuant to section 381 of the Energy Policy and Conservation Act (Public Law 94-163). Annual report to Congress.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Conservation and Solar Energy). 21 Feb 1979. 96p. Dep. NTIS, PC A05/MF A01.

This report provides an overview of the activities and achievements of the executive branch of the Federal Government in implementing the energy conservation requirements and provisions of section 381 of the Energy Policy and Conservation Act (EPCA) of 1975 (Public Law 94-163). The report describes Federal actions to develop procurement policies that promote energy conservation and efficiency, develop a Federal 10-Year Buildings Energy Conservation Plan, develop responsible public education and information programs, encourage energy conservation and energy efficiency, and promote vanpooling and carpooling arrangements. About half of the Nation's energy is used in our homes and automobiles. Another 48 percent is used by State and local governments, business and insutry, in providing needed goods and services. The Federal Government is the Nation's largest energy user, accouting for 2.2 percent of the total national energy used in 1977. This energy is used by nearly 6 million people in more than 400 thousand buildings and in the operation of more than 600 thousand vehicles. While energy conservation and energy efficiency measures alone cannot solve our immediate problems, they are an essential part of our transition to an era of scarce and expensive energy supplies.

24191 (DOE/CS/1697—01) **Evaluation of the State Energy Conservation Program from program initiation to September 1978. Final report.** (Energy and Environmental Analysis, Inc., Arlington, VA (USA)). Mar 1980. Contract EM-78-C-03-1697. 234p. NTIS, PC A11/MF A01.

The State Energy Conservation Program was established in 1975 to promote energy conservation and to help states develop and implement their own conservation programs. Base (5) and supplemental (3) programs required states to implement programs including: mandatory thermal-efficiency standards and insulation requirements for new and renovated buildings; mandatory lighting efficiency standards for public buildings; mandatory standards and policies affecting the procurement practices of the state and its political subdivisions; program measures to promote the availability and use of carpools, vanpools, and public transportation; a traffic law or regulation which permits a right turn-on-red; and procedures to carry out a continuing public education effort to increase awareness of energy conservation; procedures which promote effective coordination among local, state, and Federal energy conservation programs; and procedures for carrying out energy audits on buildings and industrial plants. All 50 states and Puerto Rico, Guam, the Virgin Islands, American Samoa, and the District of Columbia participated in the program. The total 1980 energy savings projected by the states is about 5.9 quadrillion Btu's or about 7% of the DOE projected 1980 baseline consumption of just under 83 quads. The detailed summary is presented on the following: information the SECP evaluation; DOE response to the SECP; DOE's role in the program management process; the effectiveness of the states in managing the SECP; the status of program measure implementation; innovative state energy conservation programs; and the evaluation methodology.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 23605, 23781, 24201, 24258

24192 (CEP-OP—0-2) **Shifting MX expenditures to energy efficiency: memo on the national security implications of alternative energy development.** DeGrasse, R. Jr. (Council on Economic Priorities, New York (USA)). 5 May 1980. 10p. Council on Economic Priorities, 84 Fifth Ave., New York, NY.

This project was initiated in response to a question Representative John Seiberling (D-OH) asked CEP's Director of Military Research, David Gold, about the implications of using the proposed MX expenditures in alternative ways. The alternative chosen to examine was the long-discussed goal of US energy self-sufficiency. This memo offers an estimate of the amount of oil imports which could be forgone if we invested in energy efficiency measures rather than in the MX missile. A more detailed study could better determine the actual cost of saving energy through efficiency measures and develop the necessary public policy to implement such a plan.

24193 (CONF-800403—43) **Global perspective on energy.** Anderson, T.D. (Oak Ridge National Lab., TN (USA)). 11 Apr 1980. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

From ANS thermal reactor safety meeting; Knoxville, TN, USA (8 Apr 1980).

The technological world of today finds us with a population of over 4 billion with a doubling time of 30 to 40 years. Even with the rapid introduction of effective fertility control, the momentum of population - a phenomenon caused by a population age structure biased toward the young - will carry us to a population of 12 to 16 billion in the 21st century. With fixed land resources, the energy inputs to support the increased population will be several tims the present world energy consumption. How does this conclusion square with the notion that we are running out of energy. Are the billions of new people doomed to malnutrition and disease because we cannot provide the energy needed to support them. Answering in the negative, the author says: (1) proved reserves of conventional energy resources are substantial and the prospects of adding to these reserves are good; (2) unconventional resources of oil, gas, and uranium are many times larger than our present conventional reserves; and (3) nuclear fisson energy alone could support the world for several centuries. Even though the general energy picture is bright, the outlook for the less developed countries is not, he feels. To exploit the energy sources of the future requires large capital investments - something that only the developed countries can manage. One of the major contributions the developed countries can make to those that are less fortunate is to take the pressure off oil so as to stabilize the price and supply situation. In this regard, the US is in an excellent position to take the lead.

24194 (CONF-7910153—1) **National energy problem in perspective.** Sanders, J.P. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

From Electrical engineering meeting; Huntsville, AL, USA (26 Oct 1979).

A study of the history of energy usage in this country will indicate a take off occurred in our energy consumption rate in the mid-1950s; this was followed by an increase in the use of electricity as a more convenient energy source in the mid-1960s. Associated with the generation of increasing amounts of electricity were the conversion losses that are inherent in normal steam cycles. Our future needs can be projected on the basis of the population growth and the energy consumption rate per capita. An extrapolation of these needs minus the amount of fossil fuel that we can obtain or afford to import shows clearly the demand placed on domestic supplies. After an allowance is made for the remaining fossil reserves plus optimistic projections for energy from geothermal, hydroelectric, oil shale, and solar sources, a deficit remains. It appears that nuclear fission energy is the only deveoped source that has a possibility of filling this deficit between the present and the year 2000. Past that date, there is hope that nuclear fusion energy or some other of the developing technologies will be available to supply the need.

24195 (DOE/EIA—0201/5) **Analysis of Federal Government energy emergency programs. Energy policy study, Volume 5. AR/EI-80-05.** Serot, D.E. (Department of Energy, Washington, DC (USA). Energy Information Administration). Jan 1980. 64p. NTIS, PC A04/MF A01.

The economic implications of Federal Government programs for responding to an energy emergency (i.e., a sudden, temporary reduction in energy supply) are analyzed. Section 1 considers both

the effects of the limited duration of an emergency and of the expectations of an emergency occurring; Section 2 describes the Government energy emergency programs and discusses their economic implications; and Section 3 sets forth the framework for an analysis of the costs and benefits resulting from enactment of the Government programs. The energy emergency programs discussed were developed in response to the 1973 Arab oil embargo. They include: use of the Strategic Petroleum Reserve, enactment of price controls on crude oil and refined products, mandatory allocation of crude oil and refined products, mandatory yield controls, gasoline rationing, mandatory conservation, mandatory fuel shifts, and supply enhancement programs. Thirty-seven references are appended in a bibliography. This is the fifth volume in the Energy Information Administration's Energy Policy Study papers. 3 figures.

24196 (DOE/PE—00/8) **Policy and Fiscal Guidance: energy projections. Appendix D.** (Department of Energy, Washington, DC (USA). Office of Analytical Services). Feb 1980. 53p. Dep. NTIS, PC A04/MF A01.

This document, Appendix D of DOE's 1980 Policy and Fiscal Guidance, presents a set of energy projections for use in strategic-planning activities. The forecasts reflect assumptions about key input variables - world oil prices, economic growth, nuclear capacity, domestic oil production potential, and policy initiatives - that are consistent with information available to the Office of Policy and Evaluation as of February 1980. These projections use the same analytical framework as those presented in the Second National Energy Plan (NEP-II), published in May 1979. This analytical framework is described in Appendices A and B of NEP-II (available from the Office of Analytical Services). The projections differ from those published in NE-II in the following assumptions: (1) world oil prices are higher, reflecting the June and December 1979 OPEC price hikes and the current instability in world oil markets; (2) GNP growth is lower than NEP-II, primarily a result of the expected recession in 1980; (3) domestic oil production is lower due to a reevaluation of lower-48 and offshore oil production potential; (4) nuclear capacity is assumed to expand at a slower rate of growth; and (5) Presidential initiatives are incorporated into the analysis, including the windfall profits tax bill H.R. 3919, synfuel corporaton legislation S.932, utility oil backout program - 750,000 bbls/day savings by 1990 to 1995, and conservation savings of 250,000 bbls/day.

24197 (EPRI-AF—1294) **Electricity demand and consumption by time-of-use: a survey. Final report.** Aigner, D.J.; Poirier, D.J. (University of Southern California, Los Angeles (USA); Toronto Univ., Ontario (Canada)). Dec 1979. 111p. Dep. NTIS, PC A06/MF A01.

This paper surveys the theoretical and econometric methodologies available to support empirical work aimed at the estimation of price elasticities of demand and/or consumption for electricity by time-of-day and seasonally. Such elasticities are the important quantities for use in assessing the impact of time-of-use (TOU) seasonal rates on customer well-being and utility revenues. The empirical evidence to date is evaluated in light of these methodologies. Experiments on TOU pricing for residential customers have been on-going for several years and, recently, detailed econometric analyses of those experiments already completed have been reported. For various reasons it is concluded that, while the results of some of these efforts are suggestive, at this time there is still a lack of sufficient quantitative evidence to guide policy makers even at a local level. As for other customer classes, the few instances of mandatory TOU/seasonal rates for very large power customers (in California and Wisconsin) are discussed.

24198 **Energy demand and interfuel substitution in India.** Uri, N.D. (Department of Energy, Washington, DC). *Eur. Econ. Rev.*; **12**: No. 2, 181-190(Apr 1979).

This paper applies a translog price possibility frontier to a pooled sample in order to measure the extent of energy substitution effects in the commercial sector in India. The results indicate that relative changes in energy prices have significant effects on energy consumption. 12 references, 2 tables.

24199 **Conservation and the changing direction of economic growth.** Abrahamsson, B.J. (ed.). Boulder, CO; Westview Press, Inc. (1978). 167p. (CONF-7706194—).

From Rocky Mountain Energy Economics Institute meeting; Aspen, CO, USA (26 Jun 1977).

There may be an energy supply-demand gap, at least for some time, regardless of whether the supply constraint is physical or political, says Bernard J. Abrahamsson in his introductory chapter. Other papers presented in the book are World Oil and Gas Supply: Whose Crisis, Edward W. Erickson and Herbert S. Winokur, Jr.; Energy Scarcity and the US Economic Future, James W. McKie; Intercountry Comparisons of Energy Use: Any Lessons for the United States, Joel Darmstadter; US Energy Conservation, L.G. Rawl; Coal Schizophrenia, or Be Sure Who Makes the Magic Potion, Richard L. Gordon; and Critical Choices for National Energy Policy, Milton Lipton.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 23464, 23571, 23778, 23789, 23800, 23842, 24184, 24190, 24191, 24192, 24195, 24196, 24199, 24255

24200 (BNL—27613) **Framework for energy policy and technology assessment in developing countries: a case study of Peru.** Mubayi, V.; Palmedo, P.F.; Doernberg, A.B. (Brookhaven National Lab., Upton, NY (USA)). Dec 1979. Contract EY-76-C-02-0016. 36p. (CONF-790175—1). NTIS, PC A03/MF A01.

From International conference on energy and the environment; Bangalore, India (11 Jan 1979).

The potential of various energy sources and technology options in meeting national economic and social development goals in developing countries is assessed. The resource options that are of interest are the development of indigenous resources. In general, two categories of options can be considered: those which correspond to the accelerated implementation of existing elements of the energy system and those which correspond to the introduction of a new technology, such as solar electricity. The various resource and technology options that must be analyzed with respect to a number of criteria or payoff functions are: total demand and fuel mix; reduction of oil consumption; national social goals; total energy costs; and environmental quality. First, a view is constructed of the energy implications of current national economic development plans. A consistent description of the future energy system of the country, under the assumption of current trends and policies is constructed for certain reference years in the future. The values of the payoff functions selected are then calculated for that reference case. The major resource and technology options are identified and the rates at which they can be implemented are determined. Finally, the impact on the various payoff functions of the implementation of each option is calculated. The basic element of the framework is the Reference Energy System, discussed in Secton 3. The energy policy analysis for Peru is used as a reference case. 11 references, 10 figures, 2 tables.

24201 (BNL—27721) **Economic assessment of alternative energy policies.** Groncki, P.J.; Goettle, R.J. IV; Hudson, E.A. (Brookhaven National Lab., Upton, NY (USA). National Center for Analysis of Energy Systems; Brookhaven National Lab., Upton, NY (USA)). Apr 1980. Contract EY-76-C-02-0016. 20p. (CONF-800548—2). NTIS, PC A02/MF A01.

From Eastern Economic Association annual meeting; Montreal, Quebec, Canada (8 May 1980).

Current US energy policy includes many programs directed toward the restructuring of the energy system so as to decrease US dependence on foreign supplies and to increase our reliance on plentiful and environmentally benign energy forms. However, recent events have led to renewed concern over the direction of current energy policy. This study describes three possible energy strategies and analyzes each in terms of its economic, environmental, and national security benefits and costs. Each strategy is represented by a specific policy. The first strategy is to initiate no additional programs or policies beyond those currently in effect or announced. The second is to direct policy toward reducing the growth in energy demand, i.e., energy conservation. The third is to promote increased supply through accelerated development of synthetic and unconventional fuels. The analysis focuses on the evaluation and comparison of these strategy alternatives with respect to their energy, economic, and environmental consequences. The analysis indicates that conservation can substantially reduce import dependence and slow the growth of energy demand, with only a small macroeconomic cost and with substantial environmental benefits; the synfuels policy reduces imports by a smaller amount, does not reduce the growth in energy demand, and involves substantial environmental costs and impacts on economic performance. However, these relationships could be different if the energy savings per unit cost for conservation turned out to be less than anticipated; therefore, both conservation and R, D, & D support for synfuels should be included in future energy policy.

24202 (DOE/EIA—0201/6) **Selected federal tax and non-tax subsidies for energy use and production. Energy policy study, Volume 6. AR/EA/80-01.** Bowring, J. (Department of Energy, Washington, DC (USA). Energy Information Administration). Jan 1980. 89p. NTIS, PC A05/MF A01.

Selected federal tax and non-tax subsidies for energy use and production are analyzed. The non-tax subsidies include grants, loan guarantees, and acquisition programs for the production and use of new energy technologies and for the use of conservation of energy by special groups of energy consumers. Examples of such programs are the military solar procurement program and loan guarantees for the production and distribution of power in rural areas. The tax subsidies analyzed are those that apply to investments in new technologies by energy users such as tax credits for residential and industrial solar equipment. The report is divided into three parts:

Part 1 discusses the economics of subsidies in general, outlining the rationales for subsidy programs and their likely effect on production and use; Part 2 analyzes in more detail particular types of subsidy programs, namely their effect and appropriateness; and Part 3 assesses the costs and benefits of a representative cross section of existing subsidy programs. Two appendices provide a comprehensive list of the relevant subsidy programs.

24203 (DOE/RG—0028) **Powerplant and Industrial Fuel Use Act: annual report.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). 1 Mar 1980. 70p. Dep. NTIS, PC A04/MF A01.

The major purposes of the FUA program are to reduce the importation of petroleum and increase the nation's use of indigenous energy resources; to conserve natural gas and petroleum and minimize their use as primary energy sources; to foster greater use of coal; to encourage the use of synthetic fuels; and to reduce the vulnerability of the US to energy-supply interruptions. Accomplishments in the implementation of the Act by DOE are described along with descriptions of legislation and major regulations, procedures, program effectiveness, and major implementation problems. Recommendations are summarized.

24204 (Juel-Spez—55) **Alternative scenario for energy policy: analysis, questions, and remarks on Dr. Erhard Eppler's alternative scenario for energy policy.** Schmitz, K.; Voss, A. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Programmgruppe Systemforschung und Technologische Entwicklung). Sep 1979. 75p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

The energy-political proposals and strategies presented by E. Eppler on 30 May 1979 his alternative energy policy are critically analyzed and evaluated. One main factor is to test the basic facts and analyses and the correctness of the decisions. Whether the energy-political measures proposed by E. Eppler can be transferred to reality is the question. An analysis of the most striking statements of the scenario shows that especially the numerous restrictions (concentration on the electricity section, no incorporation of energy supply in the total economical development, etc.) and an overestimation of the importance of energy savings make it impossible to realize this concept within the frame of a responsible energy policy.

24205 (NTIS/PS—79/1069) **Energy policy and research planning. Volume 3. October, 1977-September, 1979 (a bibliography with abstracts). Report for October 1977-September 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Sep 1979. 184p. NTIS PC N01/MF N01.

Citations relative to planning for future U.S. energy needs on both national and state government levels are presented. The history and development of national and state legislation and regulations, Project Independence studies, and assessment of the effects of deregulation are included. Technical, economic, and environmental considerations in energy planning are also covered. (This updated bibliography contains 177 abstracts, 175 of which are new entries to the previous edition.)

24206 (PB—301135) **Role of energy in the Indonesian economy, 1975 to 2000.** Soelistijo. U.W. (West Virginia Univ., Morgantown (USA). Dept. of Mineral Economics). Oct 1978. 208p. NTIS, PC A10/MF A01.

This report examines the role of energy in the Indonesian economy historically from 1950 and predicts the upper and lower bounds of energy production and consumption through the year 2000. The study details the composition of domestic energy use and export demands by sector and fuel under changing conditions in world energy markets. The relationship between GNP growth, population, energy consumption, investment, and exports is examined in a simple model associating the rise in capital-output ratios and GNP with the dramatic increase in oil exports and values added.

24207 **Where Carter's energy program goes wrong.** Edgerton, J. *Money;* **8**: No. 10, 50-53(Oct 1979).

Proposed is a national energy plan that the author feels would minimize public inconvenience and sacrifice while effectively achieving goals of energy independence and conservation. He says the U.S. government should: accept the necessity of importing foreign oil and concentrate on protecting the economy from supply disruptions; realize that synthetic fuels production will accelerate very slowly; help homeowners conserve energy through the use of cost-effective measures; and revise the maze of energy and environmental regulations. Most importantly, energy prices must be decontrolled, he feels.

24208 **On the Hill: energy muddlization.** Chapman, S. *New Repub.;* **181**: No. 13, 9-12(29 Sep 1979).

Controversy brewed quickly after President Carter's July 16, 1979, energy speech, in which he proposed the creation of an Energy Mobilization Board to cut through the red tape obstructing energy projects. As conceived by the White House, the board would have the right to waive any federal, state, or local law that would slow the building of any critical non-nuclear projects. The House Interior and Commerce Committees have produced their own versions of the board in two greatly different bills, which are described. The author feels that the EMB will increase rather than reduce litigation and that laws themselves should be changed, revoked, or streamlined, not just bypassed by arbitrary implementation like the EMB.

FOSSIL FUELS

REFER ALSO TO CITATION(S) 24211

COAL

REFER ALSO TO CITATION(S) 23449, 23533, 23536, 23537, 23543, 23544, 23545, 23546, 23547, 23548, 23549, 23550, 23551, 23552, 23553, 23554, 23555, 23556, 23557, 23564, 23567, 23571

PETROLEUM

REFER ALSO TO CITATION(S) 23600, 23605, 24207

NATURAL GAS

REFER ALSO TO CITATION(S) 23605

24209 (UCID—18621) **Changing patterns in world nitrogen fertilizer production and trade.** Briggs, C.K.; Borg, I.Y. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 May 1980. Contract W-7405-ENG-48. 13p. NTIS, PC A02/MF A01.

Nitrogen fertilizer production and exports are shifting from the United States, Western Europe, and Japan to countries that have the largest and cheapest reserves of natural gas, the most widely used feedstock for ammonia production. This report documents this shift using 10-year historical plots of production and consumption of nitrogenous fertilizers in developed, Communist, and less-developed countries (which include OPEC). While world production and consumption has been increasing at a rate of 6.5%/year over the past decade, the contribution of developed countries to production as a percent of the total has been steadily declining. At the same time the Communist and LCD's contribution as a percent of the total has increased. As a consequence the US has become a net importer of nitrogenous fertilizer. Exports from USSR and some Comecon countries along with OPEC have increased. Projected expansion of ammonia capacity (hence of fertilizer production) in these same countries suggest that these trends will continue. The reason for these changes lies in the changing availability and pricing of natural gas in the US and other developed countries. 8 references, 5 figures, 1 table.

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 23668

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 23776

ELECTRIC POWER

REFER ALSO TO CITATION(S) 24016, 24197

24210 (CONS—8138-T1) **Powerplant productivity improvement study: policy analysis and incentive assessment. Final report.** (Illinois Commerce Commission, Springfield (USA)). May 1979. Contract EM-77-F-01-8138. 87p. NTIS, PC A05/MF A01.

Policy options that the Illinois Commerce Commission might adopt in order to promote improved power plant productivity for existing units in Illinois are identified and analyzed. These policy options would generally involve either removing existing disincentives and/or adding direct incentives through the regulatory process. The following activities are reported: in-depth review of existing theoretical and empirical literature in the areas of power plant reliability, regulatory utility efficiency and performance incentives, and impacts of various regulatory mechanisms such as the Fuel Adjustment Clauses on productivity; contacts with other state public utility commissions known to be investigating or implementing productivity improvement incentive mechanisms; documentation and analysis of incentive mechanisms adopted or under consideration in other states; analysis of current regulatory practice in Illinois as it relates to power plant productivity incentives and disincentives; identification of candidate incentive mechanisms for consideration

by the Illinois Commerce Commission; and analysis and evaluation of these candidates. 72 references, 8 figures.

24211 (DOE/TIC—11177) **Literature review on capacity expansion planning under uncertainty. Phase II.** Soyster, A.L. (Systemetrics, Inc., Blacksburg, VA (USA)). 15 Mar 1980. Contract EI-78-C-01-6242. 84p. Dep. NTIS, PC A05/MF A01.

A literature review is presented concerning the issues and methodologies for modeling investment and capacity-expansion decisionsof the firm. The specific thrust of the review involves the treatment of uncertainty, especially in the context of capacity for the regulated utility. The first section, completely methodological in scope, is devoted to formal methods for incorporating uncertainty into mathematical programming models. The four different approaches considered are: two stage programming with recourse, chance-constrained programming, distributional analysis, expected-value/variance tradeoffs. Each of these approaches has been used or is recognized as a possible framework for models devoted to investment and capacity-planning decisions. Next, two different contemporary electric-utility capacity-expansion models are reviewed. Capacity planning for the regulated utility and a review of some econometrically based capacity expansion models are included. 44 references.

24212 (PB—300314) **An investigation of preferences for various types of energy cost feedback. Final report.** Rammey-Smith, A.; Gagnon, J.L. (National Bureau of Standards, Washington, DC (USA). Consumer Sciences Div.). Aug 1979. 71p. NTIS, PC A04/MF A01.

The present study addressed the issue of consumer preferences for various types of energy cost feedback for individual consumers. Its purpose was to provide human factors recommendations to DOE related to the performance characteristics of energy cost feedback devices for use by DOE in testing energy cost feedback meters. Simulaton and interview techniques were used to provide consumer reaction to cumulative, instantaneous, and projected feedback presented as dollar and cent values. Recommendations for feedback types as well as some performance characteristics of energy cost feedback meters for further testing by DOE are discussed.

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 24006, 24013

24213 (PB—300770) **Overview report: experiment in computer applications for regulatory agencies. Final report.** (Temple, Barker and Sloane, Inc., Lexington, MA (USA)). Sep 1979. Contract NBS-5-35894. 117p. NTIS, PC A06/MF A01.

The purpose of the Project was to provide improved analytical and managerial techniques for use in the electric utility regulatory process to learn how technological innovation could be promoted among regulated industries. Computerized tools that would reduce the time required for various analyses undertaken in rate cases and in other regulatory decision problems were developed. The study also considered the need for improvements in the quality and scope of analysis. A secondary emphasis was on managerial and administrative procedures in regulatory commissions. Four specific areas addressed were regulatory lag, rate design, performance evaluation and factor productivity analysis, and long-range planning.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 24198, 24244, 24253

SOLAR

REFER ALSO TO CITATION(S) 23799, 23800, 23878, 23885

GEOTHERMAL

REFER ALSO TO CITATION(S) 23990

OTHER

REFER ALSO TO CITATION(S) 23839, 23842, 24002, 25045

ENERGY CONVERSION

REFER ALSO TO CITATION(S) 24247

MHD GENERATORS

24214 (DOE/EV/04651—T1) **Environmental readiness document magnetohydrodynamics.** (Montana Energy and MHD Research and Development Inst., Inc., Butte (USA)). Jul 1979. Contract EP-78-C-02-4651. 44p. Dep. NTIS, PC A03/MF A01.

The major areas of environmental concern with regard to the commercialization of coal-fired MHD generators are discussed. MHD technology and expectations about its future utilization are described. Information pertinent to the technology was drawn from the DOE technology program office and from an Environmental Development Plan developed for the technology by EV and the program office through an Environmental Coordination Committee. The environmental concerns associated with the technology are examined, and the current status of knowledge about each concern and its potential seriousness and manageability through regulation and control technology, is discussed. Present and projected societal capabilities to reduce and control undesirable environmental, health, safety, and related social impacts to a level of public acceptability -- as reflected in current and proposed environmental standards -- which will allow the technology to be commercialized and utilized in a timely manner are summarized. The ERD as a whole thus provides an assessment, within the limits of available knowledge and remaining uncertainties, of the future environmental readiness of the technology to contribute to the meeting of the Nation's energy needs. (WHK)

24215 (FE—2215-13(Vol.1)) **Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978.** Louis, J.F. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Apr 1979. Contract EF-76-01-2215. 400p. Dep. NTIS, PC A17/MF A01.

Activities during the three year period of the contract are reported in detail. Separate abstracts were prepared for the four tasks reported in this volume. (WHK)

24216 (FE—2215-13(Vol.2)) **Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978.** Louis, J.F. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Apr 1979. Contract EF-76-01-2215. 492p. Dep. NTIS, PC A21/MF A01.

Activities during the three year period of the contract are reported. Separate abstracts were prepared for the six tasks described in this volume. (WHK)

DESIGN AND DEVELOPMENT

24217 (COO—4049-16) **DOE/PETC 5MW two-stage MHD pressurized coal combustor. Quarterly activity report, January 1-March 31, 1980.** Owoc, H.J. (Management and Technical Services Co., Philadelphia, PA (USA)). 29 Apr 1980. Contract EY-76-C-02-4049. 21p. NTIS, PC A02/MF A01.

Efforts during the January through March first quarter of 1980 commenced with correction of the AVCO Diagnostic Test Section (D.T.S), seal interface leakage and restraint problems in January, followed by five scroll combustor test runs in February and March with the D.T.S. installed and culminated in the achievement of MHD conditions for the first time at the PETC MHD combustion facility during two of the tests. New MHD data, never before obtained on plasma and slag temperatures, plasma bulk conductivity, slag and seed flow, was collected. To achieve MHD conditions in the 2nd stage combustor, it was necessary to oxygen-enrich the 1st stage cyclone in order to obtain higher stoichiometric oxygen ratios and develop 3900°F or higher. The modified D.T.S. operated successfully through the five tests without recurrence of the initial leakage problem, measurable internal erosion or corrosion. In addition, numerous equipment and operational improvements were made to the combustor and its support systems in an effort to make operation and maintenance more controllable, reliable and safe.

24218 (DOE/NASA/2674—80/9) **Summary and evaluation of the parametric study of potential early commercial MHD power plants (PSPEC).** Staiger, P.J.; Abbott, J.M. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Jun 1980. Contract EF-77-A-01-2674. 11p. (NASA-TM—81497; CONF-800617—2). NTIS, PC A02/MF A01.

From 7. international conference on MHD electrical power generation; Cambridge, MA, USA (16 Jun 1980).

The Parametric Study of Potential Early Commercial MHD Power Plants is described and the results of the study are summarized. Two parallel contracted studies were conducted. Each contractor investigated three base cases and parametric variation about these base cases. Each contractor concluded that two of the base cases (a plant using separate firing of an advanced high temperature regenerative air heater with fuel from an advanced coal gasifier and a plant using an intermediate temperature metallic recuperative heat exchanger to heat oxygen enriched combustion air) were comparable in both performance and cost of electricity. The contractors

differed in the level of their cost estimates with the capital cost estimates for the MHD topping cycle and the magnet subsystem in particular accounting for a significant part of the difference. The impact of the study on the decision to pursue a course which leads to an oxygen enriched plant as the first commercial MHD plant is described.

24219 (FE—2215-13(Vol.2), pp 597-684) **MHD component and system modeling.** Apr 1979.

In Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978.

The objective of this task was to provide tools for studying the operation of a coal-burning, open-cycle MHD-topped electrical power plant. Four subtasks were addressed in the attainment of this objective: (1) development of an executive computer system; (2) development of component models; (3) development of models for thermodynamic and transport properties; and (4) development of a model for systems studies of an MHD power plant. Progress is described in detail. (WHK)

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 24217

24220 (FE—2215-13(Vol.2), pp 481-596) **Studies in a disk generator.** Apr 1979.

In Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978.

The main goal of this study is to establish the performance of a disk generator with swirl, i.e., with respect to power density, enthalpy extraction, turbine efficiency, and Hall recovery. Performance results for noble gases (argon) are summarized, and the results and analysis for tests with molecular gases are given; open-cycle disk plasmas are simulated with mixtures of $N_2+CO_2+H_2$. Work on nonuniformities is described; the status of the experiment designed to study the effects of thermal/velocity wake nonuniformities on plasma properties and channel performance is discussed. The theoretical modeling for this type of nonuniformity is briefly summarized. Diagnostic development is reported. Laser interferometric, heat transfer, and spectroscopic measurements are summarized. Electron density and temperature results via measurements of the continuum radiation are assessed. The relevance of the shock-tube data to steady-flow experiments/environment is discussed; and the scalability of the performance results to large-scale generators is reviewed, i.e., scaling laws. Recommendations for future work are given, and conclusions as a result of this study are presented. (WHK)

24221 (FE—2248-23) **Joint US-USSR test of the US MHD electrode system in the U-02 facility, Phase III. Final report.** (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.). Jun 1979. Contract EX-76-C-01-2248. 362p. Dep. NTIS, PC A16/MF A01.

The U-02 Phase III Module, which incorporated lanthanum chromite based electrodes, MgO and $MgAl_2O_4$ interelectrode insulators, and used a BRUNSBOND/sup R/ nickel mesh as the attachment current lead-out material, was operated at temperature for a period of 132 hours, of which 107 hours were under full MHD conditions. This is the final definitive document concerning the joint Phase III U-02 MHD test carried out in Moscow between May 13 and May 19, 1978. The design of the electrode modules including anode and cathode walls is given, and pre-test materials data are given in detail. Data relating to the experimental conditions during the test are detailed, and module performance data are presented. Procedures and results of post-test materials characterization studies are presented. (WHK)

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 24217, 24219, 24221, 24229, 24436

24222 (DOE/NASA/2674—80/10) **Optimization of air separation plants for combined cycle MHD-power plant applications.** Springmann, H.; Greenberg, R.; Juhasz, A.J. (Linde A.G., Munich (Germany, F.R.); Latepro Corp., New York (USA); National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1980. Contract EF-77-A-01-2674. 15p. (NASA-TM—81510; CONF-800617—1). Dep. NTIS, PC A02/MF A01.

From 7. international conference on MHD electrical power generation; Cambridge, MA, USA (16 Jun 1980).

Some of the design approaches being employed during a current DOE/NASA supported study directed at developing an improved air separation process for the production of oxygen enriched air for MHD combustion are described. The ultimate objective of the study is to arrive at conceptual designs of air separation plants, optimized for minimum specific power consumption and capital investment costs, for integration with MHD combined cycle power plants. Final results will be published following completion of contract in mid-1980.

24223 (FE—2215-13(Vol.1), pp 28-109) **Electrode module materials evaluation.** Apr 1979.

In Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978.

Detailed procedures and results of four studies are reported: (1) electrical conductivity in the $FeO.Fe_2O_3$-Al_2O_3-SiO_2 system: correlation with phase equilibria in air; (2) electrical conductivity in the $FeO.Fe_2O_3$-Al_2O_3-SiO_2 system: electrical conductivity of iron alumino-silicate melts; (3) the compositions of slags in equilibrium with the spinel (Fe_3O_4-FeO-Al_2O_3) in the Al-Fe-O system; and (4) electrochemical degradation of ceramic electrodes.

24224 (FE—2215-13(Vol.1), pp 110-133) **Superconducting magnet fabrication development.** Apr 1979.

In Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978.

Three aspects of the design of base load scale MHD magnets were examined: (1) rectangular versus circular saddle windings, including the compilation of a set of programs for the computation of rectangular saddle windings; (2) formulation and experimental verification of a new criterion of cryostability based on transient thermal events; and (3) conception of base-load winding designs in the style of the construction of turbo-alternator rotors.

24225 (FE—2215-13(Vol.1), pp 134-281) **Electrode module development.** Apr 1979.

In Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978.

The purpose of this task was to conduct preliminary engineering design evaluations of selected electrode/insulator modules under simulated MHD channel conditions. For the investigation, an electrode module was proposed which consisted of a metallic base, a ceramic electrode, and a ceramic insulator. The primary fabrication technique selected for these electrode modules was arc plasma spraying, because it allows one to easily make changes in materials and processing parameters, and is also a rapid means of applying a ceramic coating to a metal base. Materials selection for electrodes was based on research done under Task 1. Processing techniques were developed to prepare large quantities of selected materials suitable for use as plasma spray powders. Electrode modules were fabricated and then tested in a simulated MHD environment. The MHD simulation consisted of a liquid hydrocarbon/air/oxygen plasma seeded with potassium, an impressed dc current, slag simulation by injection of fly ash, and no magnetic field. Evaluation of electrode modules was by many techniques ranging from visual inspection to electron microprobe analysis. The general test program for a new type of electrode module consisted of a series of tests of increasingly severe operating conditions. Often, a number of the tests could be performed sequentially during one run of the MHD Simulation Facility. The testing sequence was as follows: clean plasma (thermal proof test); seeded plasma; seeded plasma with electric current; seeded plasma with slag (fly ash); seeded plasma with slag and current. Results are reported in detail. (WHK)

24226 (FE—2215-13(Vol.1), pp 282-394) **Coal combustion studies.** Apr 1979.

In Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978.

The total amount of ash vaporized was measured over the temperature range 1500 to 2500°K. In addition, the fractional vaporization of approximately 20 elements was determined. A model for the vaporization was developed to fit the data. A plug flow coal combustion model, designed to incorporate the results from the kinetic studies, is described. (WHK)

DUCT ENGINEERING AND FLUID DYNAMICS

REFER ALSO TO CITATION(S) 24220, 24221, 24225

24227 (FE—2215-13(Vol.2), pp 395-480) **Critical phenomena in MHD generators.** Apr 1979.

In Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978.

The object of this task has been to carry out analytical work towards the clarification and quantitative modeling of several phenomena which fall under the heading of nonidealities of MHD generators. Subtasks include: (1) analysis of interelectrode breakdown; (2) analysis of the effects of bulk plasma inhomogeneities; (3) effects of incomplete mixing of seed; (4) slag and boundary layer effects; (5) effects and dynamics of wakes in disc generators; (6) analysis of boundary layer effects in diagonal channels; (7) analysis of the dynamics of MHD turbulence; and (8) the effect of a velocity gradient in the development of MHD turbulence. A detailed summary of the work and the results for each subtask is given. (WHK)

24228 (FE—2215-13(Vol.2), pp 685-707) **MHD generator modeling.** Apr 1979.

In Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978.

Significant accomplishments under this task include: (a) quasi-one-dimensional modeling of a linear channel with slag-coated walls; (b) two-dimensional modeling of the gas dynamics of a slagging-wall channel with electrical behavior modeled with the infinite segmentation approximation; (c) implementation of improved models for the plasma thermodynamic and electrical properties; and (d) initiation of finite-element techniques for the calculation of electrical behavior of channels of arbitrary cross-section. (WHK)

24229 (FE—2215-13(Vol.2), pp 847-859) **U-25 electrode development program.** Apr 1979.

In Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978.

Work on the design and fabrication of electrodes for the U-25 is reported. Electrode modules, for U-25 conditions, were designed and/or fabricated by a number of organizations (ANL, Westinghouse, MIT, Technetics, GE, et al.). Electrodes were tested at the MIT MHD Simulation Facility. Although there were many electrode failures during the program, enough information was learned to allow design of a likely, successful module. An MIT design, based on accumulated knowledge, has performed successfully. (WHK)

THERMOELECTRIC GENERATORS

MATERIALS, COMPONENTS, AND AUXILIARIES

24230 **Thermoelectric generator overload protective device using hysterisis control.** Angello, J.P. US Patent 4,129,893. 12 Dec 1978. Filed date 31 May 1977. 6p.

A thermoelectric generator is equipped with a protective device which, upon overload conditions, disconnects a primary load, such as rechargeable battery, in order to protect the secondary load, i.e., the burner, fuel pump and other ancillary items necessary to operate the thermoelectric generator. The protective device includes a voltage selectable breakdown diode, a transistor switch, a relay whose coil is connected to the transistor switch, and preferably an anti-clatter circuit. (Author)

APPLICATIONS

REFER ALSO TO CITATION(S) 23767

THERMIONIC CONVERTERS

DESIGN AND DEVELOPMENT

24231 **Solar-powered thermionic-photoelectric laser.** Fowler, H.; Israel, A. US Patent 4,168,716. 25 Sep 1979. Filed date 15 Dec 1977. 8p.

A solar-powered thermionic-photoelectric current generator is disclosed employing a paraboloidal telescope for collecting and concentrating sunlight into a narrow beam which is incident upon a thorium-doped tungsten cathode target within an evacuated envelope, the light being incident on the target at a very large angle of incidence. an anode arranged substantially parallel to the beam of light incident on the cathode target surrounds the major portion of the cathode target and extends an appreciable distance rearwardly from the cathode target. A gas impervious envelope maintains the region of space immediately surrounding the anode and cathode target at a desired vacuum. Electrical conductors leading from the anode and cathode target to points outside the gas impervious envelope can connect the anode and cathode target to an appropriate load. A laser or other similar light amplification means can be included to increase the proportion of light incident about the target which is found in the ultraviolet spectrum.

FUEL CELLS

REFER ALSO TO CITATION(S) 24102

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 24238

24232 (ANL—79-84) **Advanced fuel cell development. Progress report, April-June 1979.** Pierce, R.D.; Finn, P.A.; Kinoshita, K.; Kucera, G.H.; Poeppel, R.B.; Singh, R.N.; Sim, J.W. (Argonne National Lab., IL (USA)). Nov 1979. Contract W-31-109-ENG-38. 44p. NTIS, PC A03/MF A01.

Advanced fuel cell research and development activities at Argonne National Laboratory (ANL) during the period of April to June 1979 are described. These efforts have been directed toward understanding and improving the components of molten-carbonate-electrolyte fuel cells operated at temperatures near 925 K. The primary focus of this work has been on the development of long-life electrolyte structures composed of $LiAlO_2$ particles and Li_2CO_3-K_2CO_3 eutectic. Cell testing is performed to assess individual and collective component behavior.

24233 (ANL—79-110) **Advanced fuel cell development. Progress report, July-September 1979.** Pierce, R.D.; Kinoshita, K.; Kucera, G.H.; Poeppel, R.B.; Sim, J.W.; Singh, R.N. (Argonne National Lab., IL (USA)). Feb 1980. Contract W-31-109-ENG-38. 36p. NTIS, PC A03/MF A01.

Advanced fuel cell research and development activities at Argonne National Laboratory (ANL) during the period July-September 1979 are described. These efforts have been directed toward understanding and improving components of the molten carbonate fuel cells operated at temperatures near 925 K. The primary focus has been on the development of electrolyte structures that have good electrolyte retention and mechanical properties as well as long-term stability. A major effort this period has been on the synthesis of $LiAlO_2$ particles for the preparation of high-porosity (60%) sintered structures. The major problem has been avoidance of ionic species (unreacted Li_2CO_3 or LiOH) during sintering, which produce structures with excessive particle growth and low porosity. Initial cell tests with sintered electrolyte structures indicate that these structures can survive thermal cycles and that adequate wet seals can be obtained.

24234 (BNL—27452) **Fuel cells for electric utility and transportation applications.** Srinivasan, S. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 30p. (CONF-800324—2). NTIS, PC A03/MF A01.

From Seminar on electrochemical systems: batteries and fuel cells; Fortaleza-Ceara, Brazil (2 Mar 1980).

This review encompasses the following topics: (1) historical, (2) types of fuel cells, (3) thermodynamic and electrode kinetic aspects of fuel cells, (4) overview of present status of fuel cell research and development, (5) electrocatalysis of fuel cell reactions, (6) fuel cell/battery hybrid vehicles, and (7) regenerative hydrogen-halogen fuel cells for energy storage. (WHK)

24235 **1 kW tungsten carbide fuel cell power plant with a methanol cracker.** Maass, K.P. (AEG-Telefunken, Wedel, Germany). pp 35-37 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Schematics of the fuel cell system and methanol cracker are given. The system uses tungsten carbide gas diffusion anodes and phosphoric acid electrolyte in a porous matrix. The methanol is converted to crude gas (64.5% H_2, 29.2% CO, 5.6% CO_2) in a thermal catalytic cracker. System performance is described. (WHK)

24236 **1.5-kW methanol fuel cell power plant system design study.** Meyer, A.P. (United Technologies Corp., South Windsor, CT). pp 37-41 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

The preliminary design of a 1.5 kW methanol fuel cell power plant is described. The cooling system and low-temperature reformer are discussed. Power plant characteristics are listed. (WHK)

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 23428

24237 **Assessment of the air breathing, hydrogen fueled SPE fuel cell.** Adlhart, O.J. (Engelhard Minerals and Chemicals Corp., Menlo Park, NJ). pp 29-32 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

A brief description of the solid polymer electrolyte fuel cell technology is presented, including discussion of a 30 watt device, in which the SPE cell is integrated with a hydrogen generator. Subsequently, applicability is assessed on demonstrated or projected performance features. The specific technical approach discussed represents only one of several options available for the use of the SPE cell. (WHK)

24238 **Assessment of the solid polymer electrolyte fuel cell for mobile power plants.** McElroy, J.F. (General Electric Co., Wilmington, MA). pp 32-34 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

During the course of recent investigations to increase the current density capabilities of the hydrogen/oxygen configuration, a series of cathode air activation techniques were performed. Al-

though the hydrogen/air operation was performed purely for activation purposes, significant high current density data were obtained. Projections made from this data indicate that hydrogen/air performance at 1.0 A/cm² and 0.60 volt dc is a distinct possibility. (WHK)

24239 Diagnostic techniques for performance evaluation of fuel cells. I. Comparison of carbon monoxide tolerance of selected anodes. Walker, G.W.; Adams, A.A.; Coleman, A.J.; Joebstl, J.A. (MERADCOM, Fort Belvoir, VA). pp 41-44 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Two questions need to be addressed concerning the effect of carbon monoxide on the low loaded carbon supported platinum electrodes. One involves the supported catalyst and its intrinsic hydrogen activity in the presence of carbon monoxide while the other deals with the effect of the present level of catalyst poisons in the gas stream on the low loaded platinum electrode. If the deleterious effect of carbon monoxide on the supported catalyst is less than that on the platinum black and alloyed platinum electrodes then the costs and complexity of the present fuel cell systems could be greatly reduced. On the other hand, if the poisoning rate on supported structures is equivalent to or greater on the supported structure than that found on the other structures, then an examination of the long term performance of the supported electrodes must be made using reactants with the present level of impurities. The question of the intrinsic activity of carbon supported platinum electrodes in the presence of carbon monoxide is studied and compared to the platinum black and platinum alloy electrodes. (WHK)

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 24232, 24233, 24235

24240 Fuel cell anode electrode, method of making the fuel cell anode electrode, and fuel cell containing the fuel cell anode electrode. Perry, J. US Patent 4,141,801. 27 Feb 1979. Filed date 15 Dec 1977. 3p.

A fuel cell anode electrode for use in fuel cells utilizing fuel electrolyte mixtures of methanol in potassium hydroxide electrolyte and ethylene glycol in potassium hydroxide electrolyte is made by pressing a paste mix of noble metal powder, graphite, and teflon onto a screen current collector, drying the electrode so formed, cathodically charging the electrode at a current density of about 2 1/2 to 10 mA/sq. cm for about 2 to about 6 minutes to deposit lead through electrolysis using a saturated solution of lead chloride, anodically charging the electrode for about 2 to about 12 minutes to oxidize the lead to lead dioxide, washing the electrode with distilled water, and drying the electrode. (Author)

24241 New H_3PO_4 fuel cell electrocatalysts made from alumina/pyropolymer composites. Leyerle, R.W. (UOP Inc., Des Plaines, IL); Welsh, L.B.; George, M.A.; Baker, B.S. pp 26-28 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Electrocatalysts composed of a platinum-impregnated composite structure formed by bonding a thin-film, semiconducting pyropolymer to the surface of an electrically-insulating, high-surface area, refractory-oxide substrate were previously described. A new generation of improved electrocatalysts is now being studied. These electrocatalysts differ from the earlier types in that the refractory substrate is leached from the composite material before impregnation with platinum and fabrication into an electrode. Results are presented of the program to characterize this new electrocatalyst material and to evaluate it as an air reduction catalyst in phosphoric-acid-electrolyte fuel cells. The results of performance and lifetime tests of gas diffusion cathodes fabricated from these materials and tested in matrix-type fuel cells are discussed. (WHK)

24242 Power conditioners and fuel cell inverters. Jokl, A.L.; McKechnie, R.M. (Army Mobility Equipment Research and Development Command, Fort Belvoir, VA). pp 58-60 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

As part of its efforts to provide mobile electric power plants for the field Army, the US Army Mobility Equipment Research and Development Command (MERADCOM) pursues a broad-based program to develop general-purpose and dedicated power conditioners. In its present form, it is a multi-phase effort to provide inverters for a family of fuel-cell power plants in the 0.5 kW to 5 kW range and power processors for a family of general-purpose power conditioners in the 1.5 kW to 200 kW range. The hardware developments are supported by exploratory work on solid-state devices, modularization techniques and micro-processor efforts for control and waveform generation functions. Status of the program is described. (WHK)

APPLICATIONS

REFER ALSO TO CITATION(S) 24234

ELECTROMECHANICAL CONVERTERS

REFER ALSO TO CITATION(S) 23802

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 24190, 24361

BUILDINGS

REFER ALSO TO CITATION(S) 24176, 24191, 24197

24243 (ANL/EES-TM—81) Energy performance standards for new buildings: impact on the use of customer storage. Asbury, J.; Giese, R.; Mueller, R.; Rabl, V. (Argonne National Lab., IL (USA)). 25 Feb 1980. Contract W-31-109-ENG-38. 21p. NTIS, PC A02/MF A01.

This technical memo reviews the proposed Energy Performance Standards for new buildings and assesses their impact upon the commercial feasibility of off-peak energy storage in building heating and cooling applications. The technical data and assumptions uderlying the standards are examined with regard to their accuracy and relevance to off-peak energy storage. An estimate of the economic and scarce-fuel savings forgone under the Standards is also presented. It is recommended that temporary exceptions or exemptions for buildings with off-peak energy storage systems be granted until the Standards are modified to account for the economic and scarce-fuel benefits of off-peak energy storage.

24244 (ORNL—5552) Buildings energy use data book. Edition 2. Blue, J.L.; Lowe, K.H.; Hurlbut, B.J.; Liepins, G.E.; Rose, A.B.; Smith, M.A.; Strohlein, M.G. (Oak Ridge National Lab., TN (USA)). Dec 1979. Contract W-7405-ENG-26. 706p. (ORNL—5363(2Ed.)). NTIS, PC A99/MF A01.

This document is a statistical compendium designed for use as a desk-top reference. The data book represents an assembly and display of statistics that characterize current and past energy end-use activities in the residential and commercial sectors and presents data on other factors that influence energy use in these sectors. The purpose of the publication is to present a large amount of relevant data in an easily retrievable and usable format with the statistical data presented in the form of tables, graphs, and charts. The topics covered in the nine chapters include: (1) building stock characteristics, including construction trends, inventories, and physical and thermal characteristics; (2) appliance shipments, inventories, prices, and energy utilization efficiencies; (3) fuel production, consumption, and prices for the major energy sources (electricity, natural gas, liquid petroleum, and coal); (4) demographic and climatic variables, including data on energy use vs population by region and indicators of social changes that affect household energy consumption; (5) national economic determinants providing data on employment and unemployment, level of consumer spending, prices, government activity, and the effect of government monetary policy on the Gross National Product; (6) an overview of solar energy technology, governmental interactions, market activity, and future prospects; (7) community systems presenting data on alternative energy sources and technological options for conserving nonrenewable energy use in the major community subsystems - heating, cooling, hot water, electricity, and solid and liquid waste treatment; (8) school and hospital characteristics, inventory, and energy utilization; and (9) a review of selected analyses of energy use in the residential and commercial sectors. Data sources are listed at the end of each chapter.

24245 (ORNL/Sub—78/97726/1) Field study of moisture damage in walls insulated without a vapor barrier. Final report for the Oregon Department of Energy. Tsongas, G.A. (Seton, Johnson, and Odell, Inc., Portland, OR (USA)). May 1980. Contract W-7405-ENG-26. 124p. Dep. NTIS, PC A06/MF A01.

Considerable uncertainty has existed over whether or not wall insulation installed without a vapor barrier causes an increased risk of moisture damage (wood decay) within walls. This report

describes the results of one of the first major studies in the country aimed at finding out if such a moisture problem really exists. The exterior walls of a total of 96 homes in Portland, Oregon were opened, of which 70 had retrofitted insulation and 26 were uninsulated and were a control group. The types of insulation included urea-formaldehyde foam (44), mineral wool (16), and cellulose (10). In each opened wall cavity the moisture content of wood was measured and insulation and wood samples were taken for laboratory analysis of moisture content and for the determination of the presence of absence of decay fungi. Foam shrinkage was also measured. To evaluate the possible influence of the relative air tightness of the homes, fan depressurization tests were run using a door blower unit. The field and laboratory test results indicating the lack of a moisture damage problem in existing homes with wood siding in climates similar to that of western Oregon are described along with results of a statistical analysis of the data. Related problems of interest to homeowners and insulation installers are noted. The standard operating procedures used throughout the study are discussed, including the home selection process, quantitative and qualitative techniques used to identify wall locations with the highest moisture content, wall opening and data/sample collection methodology, laboratory analysis of samples, data processing and analysis, and applicability of the results. Recommendations for furutre tests are made. Finally, the potential and desirability for future retrofitting of wall insulation is explored.

24246 (ORNL/Sub—7470/1-V2) **Economic evaluation of the Annual Cycle Energy System (ACES). Volume II. Detailed results. Final report.** (Honeywell, Inc., Minneapolis, MN (USA). Energy Resources Center). May 1980. Contract W-7405-ENG-26. 263p. NTIS, PC A12/MF A01.

The energy effectiveness and the economic viability of the ACES concept are examined. ACES is studied in a variety of different applications and compared to a number of conventional systems. The different applications are studied in two groups: the class of building into which the ACES is incorporated and the climatic region in which the ACES is located. Buildings investigated include single-family and multi-family residences and a commercial office building. The application of ACES to each of these building types is studied in Minneapolis, Atlanta, and Philadelphia. The economic evaluation of the ACES is based on a comparison of the present worth of the ACES to the present worth of conventional systems; namely, electric resistance heating, electric air conditioning, and electric domestic water heating; air-to-air heat pump and electric domestic water heating; oil-fired furnace, electric air conditioning, and electric domestic water heating; and gas-fired furnace, electric air conditioning, and gas domestic water heating.

24247 **Alternative power sources for air force terrestrial requirements.** Barthelemy, R.R.; Hall, D.C. (Air Force Aero Propulsion Lab., Wright-Patterson Air Force Base, OH). pp 48-54 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Two years of work by the Energy Conversion Branch on USAF terrestrial energy requirements and potential methods of meeting those requirements is reported. The main objective was to determine how the USAF could achieve a most efficient terrestrial energy use state, both in terms of resources and mission impact. The governing parameters of the study were formulated, considering not only the technology options, but also the practical areas of logistics, utilization, maintenance and management. The three major sections of this report describe: the USAF terrestrial energy requirements, both at the base level and sub-base levels; the energy conversion technology that is generally applicable to USAF needs including a comprehensive data base on all these technologies; and a breakdown of the technologies most generally useful to the Air Force and a preliminary estimate of their potential, both in terms of application and energy savings. The main conclusions reached in this study are: that the USAF can benefit significantly, both from economic savings and increases in force readiness, by utilizing new and developing technology in the terrestrial area; and that certain military related requirements are not being incorporated into the new technology. The adoption and implementation by the USAF of a realistic, comprehensive energy plan is recommended. (LCL)

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 23883

24248 (BNL—27602) **R and D activities in pulse combustion at BNL.** Woodworth, L.M. (Brookhaven National Lab., Upton, NY (USA)). Nov 1979. Contract EY-76-C-02-0016. 9p. (CONF-791187—1). NTIS, PC A02/MF A01.

From Symposium on pulse combustion technology for heating applications; Argonne, IL, USA (29 Nov 1979).

The program at Brookhaven National Laboratory to upgrade the efficiency of residential and commercial building heating systems through the use of improved gas and oil burners with pulsed combustion and of heat recovery equipment is discussed. (LCL)

24249 (CONF-791242—2) **Thermal Energy Storage Test Facility.** Ternes, M.P. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 3p. NTIS, PC A02/MF A01.

From 4. annual thermal energy storage program review meeting; McLean, VA, USA (2 Dec 1979).

Two loops making up the Thermal Energy Storage Test (TEST) Facility, using either air or liquid as the thermal transport fluid, are being designed and developed. These loops will be capable of cycling residential-size thermal energy storage units through conditions simulating solar or off-peak electricity applications to evaluate the unit's performance. To date, the detailed design of the liquid cycling loop has been completed and is expected to be operational in March 1980; the design of the air cycling loop has been initiated.

24250 (CONF-800524—2) **Annual Cycle Energy System characteristics and performance.** Abbatiello, L.A. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 11p. NTIS, PC A02/MF A01.

From International congress on building energy management; Povoa de Varzim, Portugal (12 May 1980).

The Annual Cycle Energy System (ACES) provides space heating, air conditioning, and domestic water heating while using substantially less energy than competing systems providing the same services. The ACES is based on an electrically driven, unidirectional heat pump that extracts heat from an insulated tank of water during the heating season. As the heat is extracted, most of the water freezes, and the stored ice provides air conditioning in the summer. A single-family residence near Knoxville, Tennessee is being used to demonstrate the energy conserving features of the ACES. A second similar house, the control house, has been used to compare the performance of the ACES to both an electric resistance heating and hot water with central air conditioning system and an air-to-air heat pump system. The results of the first year's operation from November 1977 through mid-September 1978 showed that the ACES consumed 9012 kWh of electricity while delivering an annual coefficient of performance (COP) of 2.78. The control house consumed 20,523 kWh of electricity while delivering an annual COP of 1.13. The second annual cycle was started on December 1978. The ACES was compared with an air-to-air heat pump during this period. During the ice storage portion of this test year, December 1, 1978 to September 1, 1979, 5705 kWh of electricity was used by the ACES, compared to 12,014 kWh for the control house. The respective COPs are 1.40 for the control house with the heat pump and 2.99 for the ACES house during this period. Annual energy consumption for the test year was 6597 kWh and the annual COPs were 1.41 for the control house and 2.81 for ACES. ACES is achieving its anticipated performance. The ACES concept and its general engineering performance as compared to conventional HVAC system are described and discussed.

24251 (CSA-PAMPHLET—6143-15) **Community planning for home-heating emergencies: a guide for Community-Action Agencies and other community-based organizations.** Eccli, S.F. (Design Alternatives, Inc., Washington, DC (USA)). Oct 1979. 78p. Community Services Administration, Office of Energy Programs, Washington, DC.

First, there are brief synopses of nine historical home-heating crises (in 8 different states) and three projected crises for the 1979 to 1980 winter. These are followed by brief descriptions of an urban scenario and a rural scenario. Then an overview summarizes the steps and activities of the three main parts of this booklet: planning before an emergency strikes; activities during an emergency; and activities after an emergency. Four appendices complete the report, namely: priority list of tasks that need to be done; check-off list of tasks for volunteers; select bibliography for emergency planners; and addresses and phone numbers of useful agencies.

24252 (DOE/CS/02130—T1) **Research program on the economic feasibility and commercialization potential of the ACES system. Twenty-fourth periodic progress report.** (NAHB Research Foundation, Inc., Rockville, MD (USA)). Oct 1978. Contract AC05-77CS02130. 20p. Dep. NTIS, PC A02/MF A01.

Research studies on the cost of operating Annual Cycle Energy Systems (ACES) in houses in 12 US cities are discussed and the results tabulated. (LCL)

24253 (DOE/EIA—0207/2) **Residential energy consumption survey: characteristics of the housing stock and households.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Feb 1980. 109p. Dep. NTIS, PC A06/MF A01.

Data are provided on general structural features of residential housing units; major appliances used by the household; heating equipment and fuels used for space heating, water heating and

cooking; and demographic information about the households. The Energy Information Administration (EIA) compiled the data from the National Interim Energy Consumption Survey (NIECS). The data are presented in two ways: in weighted counts of housing units rounded to the nearest thousand and in weighted column percentages. The sample base for the report is 4081 respondents, a figure which includes all occupied residential housing units sampled in the NIECS during the winter of 1978 to 1979. This is the final version of a report first compiled by EIA in December 1979; further, this report supersedes that preliminary report. The appendices include information on how the survey was conducted, a weather zone map, a copy of the household questionnaire, a generalized sampling of errors, and a glossary. 32 tables.

24254 (DOE/EIA—0207/3) **Residential Energy Consumption Survey: conservation.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Feb 1980. 197p. NTIS, PC A09/MF A01.

This is the fourth report of the Office of the Consumption Data System, Office of Program Development, Energy Information Administration, presenting final data from the National Interim Energy Consumption Survey (NIECS). The focus of this report is the conservation activities performed by households between January 1977 and December 1978, and the status of households with respect to insulation, storm windows, and other energy conserving characteristics. These tables are from the final data file that contains imputations for missing data and includes data from the mailed questionnaires. Included in the report is a summary of findings, a description of how the survey was conducted, a copy of the questionnaire, generalized sampling errors, and a glossary of terms. This report supersedes the preliminary report (DOE/EIA-0193/P) dated August 1, 1979, for most purposes except where the user is interested in the extent of missing data.

24255 (DOE/PE/70106—T1) **Examination of implementation strategies for the Building Energy Performance Standards.** Reilly, L.J. (Harvard Univ., Cambridge, MA (USA). Energy and Environmental Policy Center). Mar 1980. Contract AM01-79PE70106. 33p. NTIS, PC A03/MF A01.

Since the passage of the Energy Conservation Standards for New Buildings Act, research has been concentrated in two distinct areas. The first area of research has involved developing the energy budget standards for different building types and climatic conditions, and refining computer programs which will be needed to evaluate the energy consumption of proposed building designs. The second major area of research has been related to developing plans for implementing these standards once they are developed. The approaches taken in each of these two areas and the problems that were encountered are described and the proposed standards are briefly examined.

24256 (PB—301143) **Weatherization training; a notebook for weatherization. Supplement Number 3: transportation.** Levy, A.; Yurkovac, F.; Florey, D. (Syracuse Research Corp., NY (USA). Energy Research Center). Feb 1979. 24p. NTIS, PC A02/MF A01.

The document represents part of a series of bulletins to provide technical assistance to administrators of programs to weatherize the homes of poor persons. Topics in this supplement include the acquisition and maintenance of trucks to transport people and materials to the weatherization project and suggestions for procedures to insure quality control and work evaluation.

24257 (PB—301200) **Residential energy conservation. Volume II. Working papers.** (Office of Technology Assessment (U.S. Congress), Washington, DC). Apr 1979. 633p. NTIS, PC A99/MF A01.

This volume contains two working papers prepared for the OTA study on Residential Energy Conservation (PB-298 410). The first paper, prepared by the Consumer Federation of America, provides information and conclusions regarding the particular problems of low-income consumers in dealing with many aspects of rising energy prices. The second work, prepared by technology and Economics, catalogs a number of technologies which may be coming into use in residences in the near future.

24258 International comparisons of the residential demand for energy. Pindyck, R.S. (Massachusetts Inst. of Tech., Cambridge). *Eur. Econ. Rev.;* **13**: No. 1, 1-24(Jan 1980).

A two-stage model of residential energy demand is constructed, in which consumer expenditures are allocated between energy and five other consumption categories, and energy expenditures are allocated across fuels. Under the assumption of homothetic separability of the energy aggregate, expenditure share equations corresponding to indirect translog utiltiy functions are estimated using pooled cross-section time-series data for a sample of nine industrialized countries. Energy demand is found to be much more price elastic than had previously been believed. The reasons for, and implications of, this result are discussed. 38 references, 7 tables.

24259 High efficiency furnace with low pollution emissions. Combs, L.P.; Okuda, A.S.; Russell, L.H. US Patent 4,138,986. 13 Feb 1979. Filed date 14 Mar 1977. 12p.

The present invention relates generally to domestic furnaces, and more particularly to a furnace which produces low levels of air pollutant emissions and can be tuned to operate efficiently.

24260 Land use controls to save energy. McCracken, C. (Central Iowa Regional Association of Local Govenments, Des Moines, IA). pp 43-46 of Iowa solar operational results conference. Des Moines, IA; Iowa Solar Office (1979).

From 1. annual Iowa solar operational results conference; Cedar Rapids, IA, USA (21 Jun 1979).

Planned development of all densities is less costly to create than sprawl in terms of environmental costs, economic costs, and energy consumption. Land use policies governing the location of new development should be examined to encourage a concentration of moderating high density development adjacent to urban activity centers. Legal means to insure energy conservation are discussed. (MHR)

OFFICE BUILDINGS

REFER ALSO TO CITATION(S) 24174

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

24261 (PB—300223) **Energy conservation and management guide for small municipalities and school districts.** (Southeast Georgia Area Planning and Development Commission, Waycross (USA)). May 1978. 93p. NTIS, PC A05/MF A01.

This comprehensive energy - saving guide contains directions for establishing an energy - cost monitoring system in the accounting department, a checklist for onsite evaluations of energy use, and energy - saving guidelines for both maintenance personnel and users of public facilities. The energy audit section contains forms which can be used to record energy usage and cost every time a bill is paid. Use of these forms to give a yearly picture of energy costs is explained. The onsite checklist has 68 points to help identify energy waste. The guidelines detail ways to save energy with reference to heat settings, settings for ventilation system fans, furnance operation, lighting, use of equipment in shops, home economics rooms, and kitchens, and use of draperies, venetian blinds, and other accessories. The guidelines also cover maintenance techniques which will not only reduce energy consumption, but will also help control maintenance costs. A recordkeeping system for mechanical maintenance is suggested. Maintenance of boilers, oil burners, steam heating systems, domestic hot water heating systems, electric heating (which is not recommended), and air - conditioning maintenance is discussed. Continued monitoring and evaluation is urged. Charts illustrate energy monitoring scales for various types of facilities. A list of other energy conservation management publications is appended.

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 24248, 24255

24262 (PB—301048) **Project evaluation and quality control.** Levy, A. (Syracuse Research Corp., NY (USA). Energy Research Center). Jan 1979. 17p. NTIS, PC A02/MF A01.

The expansion of weatherization/energy programs requires taking seriously project evaluation and quality control. Developing the ideas discussed in this report can make a program function more efficiently both administratively and for customers.

TRANSPORTATION

REFER ALSO TO CITATION(S) 24191, 24599

24263 (PB—299994) **Energy efficiency of various transportation modes.** Stucker, J.P.; Burright, B.K.; Mooz, W.E.; Klineberg, J.M.; Dunbar, F.C. (Transportation Research Board, Washington, DC (USA)). 1978. 50p. NTIS, PC A03/MF A01.

The 7 papers in this report deal with the following areas: modeling the response of the domestic automobile industry to mandates for increased fuel economy; aircraft energy efficiency technology; coal transport and coal market integration; downtown people movers and energy; energy intensity of various transportation modes; one approach to local transportation planning for national energy contingencies; and energy consumption of the journey to work with and without a suburban rapid transit line.

24264 (PB—300541) **Contributions to the foundations of supply for energy and transportation: concepts, economics, and technologies.** Sawyer, J.W. Jr. (Resources for the Future, Inc., Washington, DC (USA)). Mar 1979. 224p. NTIS, PC A10/MF A01.

This report addresses the energy problem and its possible effects on transportation, interaction between energy issues and policies, and transportation issues and policies is emphasized. The introductory section reviews the development of the energy crisis in perspective and discusses the transition to new energy sources. Following sections include: discussions of energy resource reserves; the characterization of likely future pricing of energy resources; engineering and economic descriptions of actual and potential synfuel processes; energy as a transportation fuel and as a commodity to be transported; descriptions of the energy and transportation models used; descriptions of the model runs and projections; impacts, emerging issues, and brief discussions of some of the policy options open in both transportation and energy areas. The appendix describes various forms of unconventional energy technologies such as passive solar, wind power devices, geothermal energy, and fusion.

AIR AND AEROSPACE

24265 Opportunities in Canadian transportation. Ottawa, Ontario; Science Council of Canada (Feb 1980). 133p. (CONF-791183—).

From Air as a mode/industry sub-conference; Edmonton, Canada (29 Nov 1979).

Seven papers were presented at the Air as a Mode/Industry meeting. They are: Conventional Air Services; Dash 8: A New De Havilland Airplane for short-Haul and Commuter Operations; Supplementary Air Services; Air as an Industry; Aerospace as a Canadian Industry; An Identification of Strategic Development Prospects and Problems; Whither Airline Regulation: Economists and the Industry; and Some Prognostications on Air.

RAILWAY

REFER ALSO TO CITATION(S) 24284, 24346

24266 (PB—301147) **SLRV (standard light rail vehicle) engineering tests at department of transportation, transportation test center. Final test report. Volume II. Performance and power consumption tests. Final report January-June 1976.** (Boeing Vertol Co., Philadelphia, PA (USA). Surface Transportation Systems Dept.). Feb 1979. Contract DOT-TSC-1062. 66p. NTIS, PC A04/MF A01.

The SLRV (Standard Light Rail Vehicle) is a 71-foot vehicle, articulated ro negotiate curves down to 32-foot radius and designed to operate at speeds up to 50 mph. Although the basic configuration and performance is standardized, the current operating properties (Massachusetts Bay Transportation Authority and San Francisco Municipal Railway) have specified individual requirements for auxiliary equipment and passenger accomodation. This report presents the results of the series of tests conducted. The general objective of the test program was to establish a baseline for the SLRV obtained in accordance with the General Vehicle Test Plans and to provide further experience in the use of the Test Plans in testing urban rail vehicles. Volume II contains detailed descriptions and discussions of the engineering tests performed on samples of the SLRV.

24267 (SAN—1176-T1(Vol.1)) **Energy study of railroad freight transportation. Volume 1. Executive summary.** (Stanford Research Inst., Menlo Park, CA (USA)). Aug 1979. Contract EY-76-C-03-1176. 36p. NTIS, PC A03/MF A01.

The railroad industry plays a vital role in transporting goods, raw materials, and food necessary to the well being of the population and necessary to facilitate the operations of our industrial economy. Because of the vital part that the railroad industry plays in the economy and because of its ability to move goods with relatively small amounts of fuel, the US ERDA embarked on a study to determine the role of the Federal government in promoting conservation in the industry and in freight movements in general. Toward this final objective, the study compiled a description of the railroad industry, its structure, equipment, facilities, economics, and energy consumption; compiled a description of the regulation of the industry and considered ways in which the regulation has affected fuel consumption by the railroads; and analyzed candidates for fuel efficiency improvement and evaluated them on the basis of economics and the likelihood of their adoption by industry. A description of the industry, an analysis of energy consumption by the industry, a discussion of mechanisms for evaluating efficiency improvement proposals, a description and evaluation of conservation efficiency improvement proposals, a description and evaluation of conservation opportunities, and a discussion of recommended activities are included.

24268 (SAN—1176-T1(Vol.2)) **Energy study of railroad freight transportation. Volume 2. Industry description.** (Stanford Research Inst., Menlo Park, CA (USA)). Aug 1979. Contract EY-76-C-03-1176. 146p. NTIS, PC A07/MF A01.

The United States railroad industry plays a key role in transporting materials to support our industrial economy. One of the oldest industries in the US, the railroads have developed over 150 years into their present physical and operational configuration. Energy conservation proposals to change industry facilities, equipment, or operating practices must be evaluated in terms of their cost impact. A current, comprehensive and accurate data baseline of railroad economic activity and energy consumption is presented. Descriptions of the history of railroad construction in the US and current equipment, facilities, and operation practices follow. Economic models that relate cost and energy of railroad service to the volume of railroad output and to physical and operational parameters are provided. The analyses and descriptions should provide not only an analytical baseline for evaluating the impact of proposed conservation measures, but they should also provide a measure of understanding of the system and its operations to analysts and policy makers who are involved in proposing, analyzing, and implementing such changes.

24269 (SAN—1176-T1(Vol.3)) **Energy study of railroad freight transportation. Volume 3. Regulation and tariff.** (Stanford Research Inst., Menlo Park, CA (USA)). Aug 1979. Contract EY-76-C-03-1176. 104p. NTIS, PC A06/MF A01.

Volume 1 described the history of the railroad industry and pointed out that the number of separate companies, their monopoly power, and their trade and labor practices invited regulation by outsiders from the early days. Even though new regulations have been added over the years, few have been removed. Tariffs have been modified to fit a number of needs, not all of them economic. The effects of government regulation on the energy efficiency of railroad operations are examined. The development of railroad regulation is examined and the governmental legislation, policies, and procedures that make up the regulatory environment within which the railroads must operate are briefly described. The relationship among regulations, energy usage, and costs in three specific areas of regulation: long-haul rates, empty car distribution, and rates on low-density rail traffic are examined.

24270 (SAN—1176-T1(Vol.4)) **Energy study of railroad freight transportation. Volume 4. Efficiency improvements and industry future.** (Stanford Research Inst., Menlo Park, CA (USA)). Aug 1979. Contract EY-76-C-03-1176. 154p. NTIS, PC A08/MF A01.

Railroad equipment and operating practices were largely developed in an era during which the price of fuel was a relatively minor part of the cost of railroad operations; however, fuel has now become a scarce and expensive resource. Although many opportunities exist for installing new equipment and operating practices that will result in fuel conservation, cost and market factors can promote or retard the rate at which changes are adopted, and only limited technology may be available for use in conservation applications. Conservation opportunities are identified and potential technological and operational improvements are described that can be introduced; the process of introducing new technology in the railroad industry is analyzed; the future of the railroad industry is assessed; and research and development that will contribute to the adoption of energy conservation equipment or processes in the industry are identified.

24271 (SAN—1176-T3) **Energy study of automated guideway transit (AGT) systems.** Henderson, C.; Cronin, R.H.; Ellis, H.T. (Stanford Research Inst., Menlo Park, CA (USA)). Aug 1979. Contract EY-76-C-03-1176. 99p. NTIS, PC A05/MF A01.

Automated guideway transit systems provide passenger transportation on exclusive guideways in vehicles without operators. An energy study of 6 AGT systems was made for the Seattle-Tacoma International Airport; Tampa International Airport; Busch Gardens, Wiliamsburg, Virginia; Fairland Town Center, Dearborne, Michigan; Dallas-Fort Worth Regional Airport; and West Virginia University, Morgantown, West Virinia. Selected physical, operating, and economic characteristics of the systems; services rendered; direct, indirect, and capital energy demands; and energy intensities are described.

24272 Opportunities in Canadian Transportation. Ottawa, Ontario; Science Council of Canada (1979). 122p. (CONF-7910140—).

From Bus/rail as modes and as industries sub-conference; Montreal, Canada (25 Oct 1979).

Separate abstracts are prepared for two of the five presentations made at the conference. Three papers were not in scope for the data base.

24273 Rail as an industry. Law, C.E.; Lake, R.W. pp 71-94 of Opportunities in Canadian Transportation. Ottawa, Ontario; Science Council of Canada (1979).

From Bus/rail as modes and as industries sub-conference; Montreal, Canada (25 Oct 1979).

A discussion is presented of the Japanese Shinkansen system, the most successful rail system in the world. In consideration of alternatives to the energy shortage, it is believed what Canada requires cooperative and an integrated rail/bus operation. Various industries making up the rail industry are discussed - operations, manufacturing of products, regulation and support industry, and research and development. High speed trains of the future are briefly evaluated.

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 24174, 24272, 24344, 24350, 24355, 24606

24274 (PB—299837) **Bus maintenance facility environmental analysis. Technical study.** (Rice Center, Houston, TX (USA)). Nov 1978. 294p. NTIS, PC A13/MF A01.

This report documents work conducted for the City of Houston, Texas, under the Houston-Galveston Area Council's 1977-1978 Unified Work Programs. The objective of these studies was to meet the need for environmental analysis of sites selected for the development of additional Bus Maintenance Facilities. The analysis task included cursory examinations of potential sites and detailed analysis of those sites selected for development. This document contains three reports with appendixes concerning three sites: the Polk Street Bus Facility, the South Main Street Bus Facility, and the Market Street Bus Facility. These light maintenance and storage facilities are part of a network of bus facilities designed to provide decentralized day-to-day service for the expanding fleet. Such a decentralized plan will lead to savings in energy use and deadhead time for the bus fleet.

24275 (PB—300814) **Procedures for multi-state multi-mode analysis: second year's research. Volume II. Final report.** Jones, P.S. (Georgia Inst. of Tech., Atlanta (USA). School of Industry and Systems Engineering). Jun 1979. Contract DOT-OST-80050. 139p. NTIS, PC A07/MF A01.

The document presents the results of a second-year research program, in the areas of implementation planning techniques, policy analysis, and evaluation techniques for an analytical procedure designed to identify quantitative relationships between transportation improvement programs and economic development opportunities. The transportation services of interest include both existing and developmental modes and intermodal services. The analysis focuses on the Multi-State Corridor extending from Kansas City to Brunswick-Jacksonville. Significant second year results include: (1) Concept of the success scenario, (2) Definition of a list of stakeholders for evaluation, (3) Review of alternative legislative plans, and (4) Review of alternative organization and financial plans. The focus of the third year's research will be a demonstration of the analytical technique.

24276 (PB—301117) **Analyzing the FREQ3CP freeway operations simulation model. Research report.** Ritch, G.P.; Buffington, J.L. (Texas Transportation Inst., College Station (USA)). Oct 1978. 121p. NTIS, PC A06/MF A01.

The report is intended to more thoroughly describe the FREQ3CP freeway simulation and priority ramp control computer program and its application on Interstate Highway 10 West in Houston, Texas. A procedure for obtaining the freeway and ramp traffic operations data (speeds and volumes) is described along with the presentation of the traffic data in its computer program compatible form. The calibrated computer program model of the peak period freeway traffic operations for both the AM inbound and PM outbound directions is obtained when the simulation program results aproximate the field measured traffic data. The background information for the implementation of an economic analysis computer program was collected, updated and structured. Travel time, vehicle operating and accident cost were selected to be implemented along with fuel consumption and pollution emission data for Texas facilities.

24277 (PB—301152-SET/SL) **Freight transportation energy use.** (Caci, Inc.-Federal, Arlington, VA (USA)). Jul 1979. 563-in 4vp. NTIS PC E12.

24278 (PB—301153) **Freight transportation energy use. Volume I. Summary and baseline results. Final report August 1976-October 1978.** Bronzini, M.S. (Caci, Inc.-Federal, Arlington, VA (USA)). Jul 1979. Contract DOT-TSC-1252-1. 60p. NTIS, PC A04/MF A01.

The overall design of the TSC Freight Energy Model is presented. A hierarchical modeling strategy is used, in which detailed modal simulators estimate the performance characteristics of transportation network elements, and the estimates are input to a multimodal transportation network model which emulates system performance. The purpose of the model is to predict the impacts of changes in modal technology and operations on transportation energy use, costs, service levels, and on shipper modal choice decisions. The model can also generate energy-optimal freight transportation usage patterns and predict the consequences to carriers and shippers of energy-use optimization. Model calibration results for a base year (1972) and baseline estimates for the year 1990 are presented.

24279 (PB—301154) **Freight transportation energy use. Volume II. Methodology and program documentation. Final report August 1976-October 1978.** Bronzini, M.S.; Miller, R.C. (Caci, Inc.-Federal, Arlington, VA (USA)). Jul 1979. Contract DOT-TSC-1252-2. 227p. NTIS, PC A11/MF A01.

The structure and logic of the transportation network model component of the TSC Freight Energy Model are presented. The model assigns given origin-destination commodity flows to specific transport modes and routes, thereby determining the traffic load placed upon each network element, and produces transportation cost, transit time, and energy-use estimates at several levels of detail. User and programmer instructions, including input data formats, program computation methods, and program output descriptions and examples are provided.

24280 (PB—301155) **Freight transportation energy use. Volume III. Freight network and operations database. Final report August 1976-October 1978.** Bronzini, M.S. (Caci, Inc.-Federal, Arlington, VA (USA)). Jul 1979. Contract DOT-TSC-1252-3. 136p. NTIS, PC A07/MF A01.

The data sources, procedures, and assumptions used to generate the TSC national freight network and operations database are documented. National rail, highway, waterway, and pipeline networks are presented, and estimates of facility capacity, travel speed, fuel consumption, and average cost are made. Commodity characteristics and interregional flows are also presented.

24281 (PB—301156) **Freight transportation energy use. Volume IV. Analysis of selected energy conservation options. Final report August 1976-October 1978.** Bronzini, M.W. (Caci, Inc.-Federal, Arlington, VA (USA)). Jul 1979. Contract DOT-TSC-1252-4. 140p. NTIS, PC A07/MF A01.

The TSC Freight Energy Model is applied to a preliminary analysis of two energy conservation options: (1) increased use of Run-Through TOFC rail service; and (2) use of double 40-foot trailers on all divided highways. These options are examined primarily within the limited context of competition for movement of intercity freight which presently moves in single trailer highway service.

24282 (PB—301172) **Current issues in statewide transportation planning.** Fleet, C.; Kashuba, E.; Jilek, G.; Osborne, R.; Wilson, N. (Transportation Research Board, Washington, DC (USA)). 1979. 40p. NTIS, PC A03/MF A01.

The following topics are discussed: critical issues in statewide transportation planning; new approaches in state transportation planning; Resort transportation improvements: case of Little Cottonwood Canyon, Utah; impact of population and energy on transportation needs: multimodal approach; and transportation energy overview--emphasis on New York State.

24283 (PB—301319) **Characteristics of urban transportation systems: a handbook for transportation planners. Final report.** Sanders, D.B.; Reynen, T.A. (De Leuw, Cather and Co., Chicago, IL (USA)). Jun 1979. Contract DOT-UT-20019. 194p. NTIS, PC A09/MF A01.

The report consists of a handbook to be used by transportation planners and urban specialists for estimating system parameters for conventional transportation technoloy. Three modes are evaluated: rail transit, local bus and bus rapid transit, and highway systems. Each mode contains an assessment of the following seven selected supply parameters: speed, capacity, operating cost, energy consumption, pollutant emissions, capital costs, and accident frequency. These parameters are organized as proxy variables in describing the characteristics of each transport mode.

24284 (UMTA-MA—06-0049-79-10) **Analysis of user cost and service trade-offs in transit and paratransit services.** Louviere, J.; Kocur, G. (Urban Mass Transportation Administration, Washington, DC (USA)). Aug 1979. 154p. NTIS.

The Xenia Model Transit Service served as a test of several alternative transit services operated in a small city setting. Research was designed to test a new method for assessing user tradeoffs in costs and service based on attitudinal methods. Termed direct response assessment, the methods were developed in psychology and have been extended to application in utility assessment. A tradeoff survey was administered as part of a home interview survey. Data from the tradeoff survey were used to develop separate equations for each sample respondent to explain and describe their tradeoffs over transit fare, travel time, walk distance, type of service, and headway. An aggregate equation was also developed, assuming that all respondents shared common tradeoffs. These equations were employed to retrospectively predict changes in transit system patronage since system inception in 1974. Both sets of models performed well, producing forecasts that were in the same direction and range of experience, although magnitudes were somewhat different. Coefficients of the individual tradeoff equations were then analyzed to see if they could be predicted on the basis of interpersonal characteristics of the respondents. Results indicated that differences in coefficients could be attributed to some differences in individuals such as income and auto ownership. Overall results were promising for policy evaluation and forecasting.

24285 Opportunities in Canadian transportation. Ottawa, Canada; Science Council of Canada (1980). 136p. (CONF-7910133—).

From Auto as a mode/industry sub-conference; Toronto, Canada (4 Oct 1979).

Separate abstracts were prepared for the three papers presented at the conference.

24286 Emergency of the auto as the free vote mode. Blair, A. pp 25-33 of Opportunities in Canadian transportation. Ottawa, Canada; Science Council of Canada (1980).

From Auto as a mode/industry sub-conference; Toronto, Canada (4 Oct 1979).

The many attributes of the automobile that have enabled it to assume its current position of dominance in intercity passenger transport are discussed. These include: ease of access; multi-purpose travel capability; provision of strike-free service; travel time competitiveness with rail and bus service; and perceived low operating costs relative to competing modes. Recent escalating operating costs of the auto owner (which have been paralleled in rail and bus services) would not likely obviate the auto's major attributes to any great extent or threaten its dominance. It is suggested that energy constraints would place limits on auto use. Referral is made to a study on direct and indirect demand of auto, bus, and rail within the Ottowa-Nontreal-Tronto triangle. Present and projected 1990 auto fleet average energy intensities in the trangle were compared to conventional and projected 1990 bus and rail energy intensities.

24287 Automobile mode: present status and future role. Khan, A.M. (Carleton Univ., Ottawa, Ontario). pp 36-78 of Opportunities in Canadian transportation. Ottawa, Canada; Science Council of Canada (1980).

From Auto as a mode/industry sub-conference; Toronto, Canada (4 Oct 1979).

The auto mode faces challenging problems and issues in the coming decade. These include: the automobile's dependence on petroleum based fuels (Canada's net crude self-sufficiency has dropped to 77% forcing it to be dependent upon unreliable oil imports for 23% of its needs and the auto is particularly vulnerable having accounted for consumption of 15% of Canada's total secondary energy in 1976); the impact of auto down-sizing, materials substitution and recycling on the mineral industry, and on the Canadian economy in general; concerns regarding the continuing high rate of auto accidents, fatalities and injuries, the implications of automobile downsizing on these; and problems associated with control of exhaust emissions and air quality in cities. Management measures that could be undertaken with the intention of retaining the auto in its present role and gearing it to forthcoming energy efficienct, air quality, and safety demands include periodic motor vehicle inspections; engine technology developments for broad cut petroleum fuels and alternate fuels; further research into electric vehicles; further investigation of intercity auto travel response to increases in the domestic price of crude oil; controls on infrastructure provision and/or capacity expansion on intercity highways; limiting highway speeds; fuel rationing; development of more effective communications means; and differential application of exhause controls according to location of use communities vs large cities.

24288 Improving the intercity bus through transportation systems management. Morrall, J. (Univ. of Calgary, Alberta); Mayne, J. pp 96-112 of Opportunities in Candian transportation. Ottawa, Canada; Science Council of Canada (1979).

From Bus/rail as modes and as industries sub-conference; Montreal, Canada (25 Oct 1979).

Transportation systems management (TSM) alternatives for the intercity express bus which would be viable in most if not all Canadian intercity corridors are presented. The roles of the various levels of government in relation to intercity bus service are discussed. A general description and the role of the intercity bus in the Edmonton-Calgary corridor in light of these issues are provided. TSM improvements for the intercity bus that include expanded frequency of service, perferential treatment measures, premium service, terminal access, terminal function and location improvements, and inter-modal bus-air co-ordination are suggested. Provincial and Municipal governments will play a key role in initiating such improvements. The role of the Canadian Federal government is discussed. In addition to a direct impact through the potential implementation of Part III of the Natioal Transportation Act, the greatest Federal impact could be through subsidy of passenger rail service. This subsidy places the bus industry in an unfair competitive position, particularly in low density intercity corridors which is the situation in most of Canada. All levels of government must reconsider their respective transportation policies in a multi-modal context, to ensure that these policies are not counter-productive.

24289 (PB—300617) Modelling the demand for long-distance day trips to the lake district. Greening, P.A.K.; Miles, J.C. (Transport and Road Research Lab., Crowthorne (UK)). [nd]. 29p. NTIS, PC A03/MF A01.

In this report a comparison of long-distance day trip making to the Lake District is made using data from surveys conducted in 1966 and 1974. The effect on the growth in the number of day trips by changes in car ownership levels, new motorways and increased fuel costs are discussed. The trip attraction models derived from the 1966 data contain some deficiencies and these are described. A new model is derived from the improved data base of the 1974 survey. Finally, methods of forecasting future trips are proposed based on generalised cost formulas, changes in travel time and car ownership

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 24198, 24649

ENERGY SOURCES

REFER ALSO TO CITATION(S) 24305

24290 (EGG—2027) Welding industry. Potential for energy conservation. Smartt, H.B.; Hood, D.W.; Jensen, W.P. (Idaho National Engineering Lab., Idaho Falls (USA)). Apr 1980. Contract AC07-76ID01570. 41p. NTIS, PC A03/MF A01.

An estimate is presented of the annual primary energy consumption by welding processes in the US, as 3.2 to 8.8 x 10^{16} J (3.0 to 8.4 x 10^{13} Btu), and energy conservation opportunities are discussed. The estimate has been confined to the primary energy required to actually produce coalescence. Indirect energy consumption - such as that for joint preparation, preheat, postweld heat treatment, fume removal, or other operations required by welding - has been discussed but not included in the total. The heat content of fuels used in most US power plants is termed primary energy, and it is the amount of primary energy required for welding that is estimated in this work. Welding processes have been categorized as follows: those for which energy consumption may be related to use of consumable materials, those for which it may be related to quantity of manufactured product, those for which it may be related to the number of welding machines, and those for which only limited data are available. Methodologies have been developed to estimate the energy consumption for the first three categories. The major consumers of welding energy are oxyfuel gas welding, arc welding, and resistance welding. It is significant that arc welding accounts for over 90% of electrode and filler wire consumption, yet oxyfuel gas welding accounts for about 47% of energy consumption. Arc welding consumes about 39%, and resistance welding less than 15% of the total welding energy.

MATERIALS

REFER ALSO TO CITATION(S) 23793

24291 (COO—4929-5) Use of precalciners to remove alkali from raw material in the cement industry. Quarterly technical progress report, August-October 1979. Gartner, E.M. (Portland Cement Association, Skokie, IL (USA)). Dec 1979. Contract EM-78-C-02-4929. 36p. NTIS, PC A03/MF A01.

Research on methods for removing alkalies from argillaceous materials used to produce cement is reported. These methods include chloride volatilization, use of calcium sulfate to decompose the raw materials, alkali volatilization using amides of Na and K, and sulfatefusion. (LCL)

24292 (DOE/CS/40221—6) Sulfate specifications as a constraint to gypsum addition to cement and possible replacement of gypsum as an additive. Phase I. Final quarterly technical progress report, December 1979-January-February 1980. Kantro, D.L. (Portland Cement Association, Skokie, IL (USA)). Apr 1980. Contract AC02-78CS40221. 14p. NTIS, PC A02/MF A01.

The results obtained during this quarter indicate that, based on x ray diffraction observations, rapid uptake of sulfate can be effected in low C_3A systems. This uptake is of sulfate accompanying akali and is by the aluminoferrite phase. Expansion studies indicate low expansions by low C_3A systems. Further reductions in expansion occur with the use of admixtures. The lowest expansions occur in high alkai sulfate containing systems. This result is consistent with the observation of rapid sulfate uptake in such systems. Carbonate addition results indicate that increasing carbonate content decreases rate and extent of outside sulfate attack. With respect to compressive strength, there appears to be an optimum value for carbonate addition to a high akali-high C_3A clinker. Addition of ground dolomite gives results similar to those for limestone. Use of a high-fineness limestone has a strength-enhancing effect and no adverse effect on flow.

24293 (LBL—10520) Advanced electron beam techniques for metallic and ceramic protective coating systems. Boone, D.H.; Fairbanks, J.W. (California Univ., Berkeley (USA). Lawrence Berkeley

Lab.). Feb 1980. Contract W-7405-ENG-48. 27p. (CONF-800235—1). NTIS, PC A03/MF A01.

From ASM/SAMPE conference on specialized cleaning, finishing and coating processes; Los Angeles, CA, USA (5 Feb 1980).

The need for protective coatings in energy conversion equipment operating at high temperatures with non-petroleum alternative fuels is discussed. The development of electron beam evaporation physical vapor deposition (EB-PVD) processes for applying such ceramic coatings is described, and current research is reviewed. It is concluded that the needs for the use of protective coatings will continue to increase as our quest for greater energy efficiency and more diversified fuel sources expand. Overlay coatings and composite system will be required to meet these requirements in a cost effective manner consistent with materials availability. These needs have spurred interest and activity in the overlay coating processing area in general and in EB-PVD techniques in particular where even greater activity is predicted in the future. (LCL)

24294 Sputtered oxide/indium phosphide junctions and indium phosphide surfaces. Tsai, M.; Fahrenbruch, A.L.; Bube, R.H. (Department of Materials Science and Engineering Stanford University, Stanford, California 94305). E(29-2)-3727. *J. Appl. Phys.;* **51**: No. 5, 2696-2705(May 1980).

The reason that sputtered indium-tin oxide (ITO)/InP solar cells junctions with large lattice mismatch have the same efficiency as CdS/InP junctions with good lattice match is shown to be that sputtered ITO/InP junctions actually consist of n^+-ITO/n-InP/p-InP buried homojunctions. To demonstrate this and to show that the homojunction formation is caused by thermal damage to the InP surface during sputtering deposition rather than from impurity diffusion from the oxide, a series of five different metal oxide/InP junctions have been formed by sputtering of the oxide, all with high solar efficiency. Junctions have been prepared both from single-crystal InP : Cd and from epitaxial crystal films of InP : Zn. The effects of sputter deposition of the oxide have been simulated by sputter etching of the InP surface, and the effects analyzed through measurements of the properties of Au/InP junctions, and of the Hall effect and photoluminescence of InP surfaces. Some heat treatment of the sputtered cells is required to achieve maximum efficiency, but excessive heat treatment causes degradation and often transformation from homojunctionlike to heterojunctionlike solar cell behavior. An actual In_2O_3/InP heterojunction solar cell has been prepared by thermal oxidation of the InP.

24295 Overlapping pulse technique for imaging space-time-density contours in a gas. Schmieder, R.W. (Sandia Laboratories, Livermore, California 94550). *J. Appl. Phys.;* **51**: No. 4, 1871-1872(Apr 1980).

A technique is proposed for obtaining high-resolution space-time-density images in an inhomogeneous gas sample. The method utilizes overlapping pulses of laser and/or microwave radiation such that avalanche breakdown occurs only where the density is a preselected value and when the pulses overlap. The breakdown produces local plasma regions of high luminosity that can be detected easily, even in the presence of high chemiluminescent or incandescent background.

24296 Hysteresis-corrected calibration of manganin under shock loading. Vantine, H.C.; Erickson, L.M.; Janzen, J.A. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Appl. Phys.;* **51**: No. 4, 1957-1962(Apr 1980).

The coefficient of electrical resistance of manganin was measured under shock loading and ramp unloading. We made 64 measurements of loading stress in the 1.3—40.5-GPa range and 22 measurements of unloading stress in the 1.9—23.2-GPa range. The average loading coefficient was 14% larger than the average unloading coefficient: a clear measure of resistance hysteresis. The source of the hysteresis is attributed to an irreversible resistance change in manganin caused by shock damage. We present techniques to correct for the effects of this irreversible resistance change. With this correction, both loading and unloading levels showed the same average coefficient of resistance 0.02210.004 per GPa. Our unified calibration procedure can be very useful for analyzing complex stress signals that are produced, for example, by reactive shock waves.

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 23467, 24498

24297 (COO—4930-1) **Potential for energy conservaton in the metal forming industries. Progress report, July 1, 1978-August 15, 1979.** Avitzur, B.; Beidleman, C.R.; Smackey, B.M. (Lehigh Univ., Bethlehem, PA (USA)). Aug 1979. Contract EM-78-S-02-4930. 178p. NTIS, PC A09/MF A01.

Reduced energy consumption and improved product attributes are realizable benefits that are achievable through the adoption of optimal metal forming techniques. With the meteoric rise in energy costs, certain segments of the metal forming industries have accelerated their efforts in switching from energy intensive manufacturing techniques, e.g., casting, to metal forming, and, furthermore, from hot forming and machined components to cold forming, notably the automotive industry. The first year results of a two year study that will identify and document potential energy and cost savings associated with the adoption of low energy consumption techniques are presented. When compared with techniques requiring energy for hot forming, heat treatments, and excess or scrap material, the utilizaton of alternative metal forming processes offer considerable promise for energy savings. Descriptions of savings achieved by a combination of analytical methods and imaginative new processes are provided in the form of specific industrial case studies. The elimination of defects through the use of an analytical criteria for the prevention of the central burst is presented. Such available criteria for central burst serve as a justification for the desirability to develop criteria for the prevention of fishskin and other defects. Other savings which may be possible through the development of new technologies are included in an Appendix entitled: Recent Developments in Wire Making. One specific new process, Continuous Hydrostatic Extrusion, has been developed at Western Electric and is described in detail.

24298 (DOE/CS/40021—1) **ALINET: a model for assessing energy conservation opportunities in the food processing industry. Final technical report, September 1977-December 1979.** Levis, A.H.; Ducot, E.R.; Levis, I.S.; Webster, T.F. (Systems Control, Inc., Burlington, MA (USA)). Dec 1979. Contract EC-77-C-03-1732. 263p. NTIS, PC A12/MF A01.

ALINET is a network model designed for the analysis of energy use in the food processing and distribution sector and for the evaluation of the potential effectiveness of energy conserving technologies. The conceptual framework of the model, as well as the design and implementation of the computer software are described. The wheat system at the national, state, and facility-specific level is used to illustrate the model's operation and use. A pilot project, carried out in cooperation with industry, is described in which energy use in (a) hard wheat milling, and (b) durum milling and pasta manufacture is analyzed. Finally, the introduction of an alternative technology for pasta drying is assessed in terms of energy conservation and cost. Recommendation for further applications and institutionalization of the model are made.

24299 (DOE/CS/40056—T1) **Application of foams to the processing of fabrics. Phase-III. Technical progress report, September 1, 1979-February 29, 1980.** Namboodri, C.G. (United Merchants Research Center, Langley, SC (USA)). Mar 1980. Contract AC02-77CS40056. 20p. NTIS, PC A02/MF A01.

Reducing the water required to wet process fabric reduces energy consumption since less energy is required to evaporate the water. This is accomplished by replacing much of the water with air, making foam and using it as an application medium. By the end of February 1980 approximately 300,000,000 yards of fabric had been foam finished. A number of finish formulations were optimized and second-generation foam formulations have been introduced since September 1979. Plant energy data from three UM and M plants show great savings. Considerable work has been done on developing applicators to apply dye and finish uniformly to flat goods. Evaluations of various application techniques to produce commercially acceptable dyeings are discussed.

24300 (ORO—5099-T2) **Energy conservation in the textile industry. Phase II. Final report, June 1977-August 1978.** Cook, F.L.; Carr, W.W.; Tincher, W.C.; Brookstein, D.S.; Carter, W.C.; Clark, J.L. (Georgia Inst. of Tech., Atlanta (USA). Engineering Experiment Station). Oct 1978. Contract EY-76-S-05-5099. 420p. NTIS, PC A18/MF A01.

Phase I developed a profile of the energy consumption of major energy intensive wet processes in the textile manufacturing industry and identified major energy intensive wet processes where energy conservation research would be most productive. It is briefly described and Phase II developed and demonstrated, on a pilot or full scale basis, energy conserving modifications for selected processes identified in Phase I and analyzed additional areas of energy research identified in Phase II; examined cost-benefit relationships of proposed process modifications; and disseminated research results to the industry through short courses, workshops, trade publications, organizations, and relevant Georgia Tech courses. Some of the more promising advancements in the wet processing area discussed are dyeing, preparation of fabrics, and finishing.

24301 (PB—301042) **Resource-conserving agricultural production methods. Progress report August 1977-July 1978.** (Washington Univ., St. Louis, MO (USA). Center for the Biology of Natural Systems). 1 Aug 1978. 100p. NTIS, PC A05/MF A01.

Studies of energy savings and ancillary aspects of organic and conventional farms in the Corn Belt, sewage sludge application on Midwest cropland, and irrigation from wells in the Great Plains are reported. Comparative experiments were conducted to determine

yields of maize, soybeans and winter wheat on two types of farms: those with no herbicides, insecticides or inorganic fertilizers. No significant difference were found for corn or maize, but wheat yields were 42 percent lower on organic fields. Use of sewage sludge as a fertilizer and soil amendment provides a low energy cost waste disposal method that furnishes plant nutrients and organic matter at little or no cost. Energy and ground water depletion problems encountered in irrigating from deep wells in the Great Plains have been found to be dependent on variables involving both climate and soil type. Devlopment of a method to resolve this problem is described.

24302 (PB—301244) **Energy conservation in industry; the present approach, the future opportunities. Final report.** Berg, C.A. (Berg (Charles A.), Buckfield, ME (USA)). May 1979. Contract EQ7AD505. 96p. NTIS, PC A05/MF A01.

Possible opportunities for industry to conserve energy through the introduction of new technology are considered. These new technology options may offer far greater savings of energy and of all other resources required in production than modifying the operation of existing plants, toward which present energy conservation efforts are directed. The present nearly exclusive emphasis on cost-effective modifications of existing plants to conserve energy may work less quickly to effect savings of fuel (and other resources) and at higher costs in the long run than efforts to stimulate ue of new technology in industry.

24303 (SAN—1731-T3) **Multifrequency factory operations. Final report.** (Varigas Research, Inc., Timonium, MD (USA)). 1980. Contract EY-77-C-03-1731. 141p. NTIS, PC A07/MF A01.

This study examined the potential for energy savings which exists when a factory is operated from multiple frequency electric power. In a previous study it was demonstrated that power hand tools operating from 360 to 400 Hz electric power achieve significant energy savings compared to the currently popular compressed air power tools. Fluorescent lighting and high intensity discharge lighting also are known to be more energy efficient when operated from electric power at frequencies higher than 60 Hz. Because the energy input to lighting and tooling is almost entirely converted to heat in the factory, energy conserved through more efficient tooling and lighting will also influence the heating and air conditioning requirements of the factory. The current study has developed quantitative data and methods which permit an engineering assessment of the energy savings potential from multiple frequencies in any specific factory are provided. Incremental energy savings estimates were developed which can be applied to any factory on the basis of the number of square feet in the factory. Areas within the factory at different light levels or with different amounts of tooling can be treated independently. This study was divided into six tasks as follows: energy savings from high frequency tooling; energy savings from high frequency lighting; multifrequency generator/conversion configurations; methods for including multifrequency savings in co-generation systems; relative cost requirements; and a field investigation of recent co-generation installations to determine the compatibility of such systems with multifrequency operations. It is concluded that there are appreciable savings in energy to be realized through multifrequency operations and the data and methods required to compute these savings in any specific factory are provided.

24304 **Optimization technique for minimizing the cost of self-powering industrial HVAC systems.** Cowen, D.S.; Daniels, E.J. Chicago, IL; Institute of Gas Technology, (1980). 6p. (CONF-800101—19).

From Systems simulation and economics analysis conference; San Diego, CA, USA (23 Jan 1980).

A generalizable cost optimization technique for designing industrial heating, ventilating, and air conditioning (HVAC) systems is given that includes components that produce both power and heat. It is shown that intuition - design based on only the initial capital costs of the subsystems or components - could result in a less than optimal operating system. The analysis reveals that as the total cost of owning and operating HVAC systems becomes increasingly sensitive to costs other than initial capital costs, optimization techniques become essential.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 24319, 24507

24305 (CONF-800548—1) **Price incentives of industrial cogeneration.** Maddigan, R.J. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 17p. NTIS, PC A02/MF A01.

From Eastern Economic Association annual meeting; Montreal, Quebec, Canada (8 May 1980).

One of the strategies of current national energy policy is to promote the combined production of electricity and steam at industrial sites. The impact of relative electricity and fuel prices on the decision to cogenerate is examined here. The strategy of the study is to compare the costs of two firms that are identical except for the way they acquire electricity: one firm purchases electricity while the other cogenerates. Using this framework, the relationship between the elasticity of the price of electricity with respect to the price of fuel and the parameters of the production function is shown to be a key to the decision to cogenerate. Some preliminary empirical estimates of this relationship are also presented.

24306 (CONF-800549—1) **Thermally driven open-cycle heat pump system.** Chen, F.C. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 9p. NTIS, PC A02/MF A01.

From 11. annual modeling and simulation conference; Pittsburgh, PA, USA (1 May 1980).

The technical feasibility of a thermally driven open-cycle heat pump is analyzed through the design simulation. It is intended to utilize waste heat from Federal nuclear facilities via temperature augmentation for process-steam production. Based on the simulation analysis, the design of the open-cycle heat pump to supply 4535 kg/h (1×10^4 lb/h), 121°C process steam is within the state-of-the-art. Its energy savings and cost estimate as compared to a baseline case and the alternatives are also presented.

24307 (DOE/CS/40167—T1) **Demonstration of energy conservation for multi-deck board dryers. Phase I. Final report.** (Johns-Manville Sales Corp., Denver, CO (USA). Research and Development Center). 8 Feb 1980. Contract AC03-78CS40167. 123p. NTIS, PC A05/MF A01.

A study was made to determine the feasibility of recover and reuse of low level heat from the exhausts of multi-deck dryers used to dry boards in the building materials industry. There are approximately 1000 dryers of this type in the USA, with no heat recovery equipment. These dryers are used in the manufacture of: roof insulation board, ceiling tile and panel stock, wood fiber sheathing, gypsum board, and veneer plywood. Pilot scale tests and analyses show that heat recovery designs utilizing several types of heat exchange equipment are feasible. These include the following: indirect contact air-to-air heat exchangers for preheating combustion air for the dryer furnaces; direct contact air-to-water heat exchangers using water sprays to heat process water; and indirect contact air-to-liquid heat exchangers to heat recirculating liquid in a plant building heating system. The systems recommended for design and installation at the Rockdale plant include all three of the types of heat exchangers. The preliminary estimate for the installed cost for these systems at the Rockdale plant is $565,000 (1979 dllars). Annual heat recovery of 186,000 million Btu is projected with a value of $545,000 using gas costs of $3.00 per million Btu. Payback based on a discounted cash flow analysis using ten year depreciation is about two years.

24308 (DOE/CS/40255—1) **Potential industrial applications for fluidized-bed waste heat recovery systems.** Cox, D.; Lytton, M.; Rao, C. (Mitre Corp., McLean, VA (USA). METREK Div.). Dec 1979. Contract AC01-79CS40255. 201p. NTIS, PC A10/MF A01.

Information was developed on potential applications of Fluidized-Bed Waste Heat Recovery Systems (FWHRS) in US industries that will assist the DOE in their decision to plan and participate in a demonstration project of the FWHRS. The study included a review of the literature and personal contacts (via telephone) with industry personnel with the objective to identify a limited number of applications. Technical and economic assessments for specific applications were accomplished by developing generalized design, performance, and cost parameters that could be applied based on selected critical characteristics of each potential application of the FWHR system. Waste energy streams identified included flue gas and off-gas from boilers, furnaces, and kiln. Utilization of the waste energy recovered included electric power generation, preheating combustion air and boiler feedwater, and drying. A course of action is recommended to DOE regarding generic users for demonstration projects.

24309 (DOE/ET/15350—T1) **Design study of a two-phase turbine bottoming cycle. Final report.** Studhalter, W.R. (Biphase Energy Systems, Santa Monica, CA (USA)). 15 Jun 1979. Contract EY-76-C-03-1207. 123p. NTIS, PC A06/MF A01.

The use of a biphase turbine system to recover waste heat from diesel engines was examined and found to have many favorable attributes. Among these were low rpm, high torque, low heat exchanger cost, and simplicity. Several candidate working fluid combinations were tested at temperatures of interest. The contact heat exchanger concept was substantiated by large scale experiment. The program includes subscale tests of key hardware components of a biphase turbine bottoming system. These are the two-phase nozzle, two-phase turbine, and direct contact heat exchanger. A comprehensive cost analysis was completed. A three-year program leading to a full-size system field demonstration has been planned. Progress in the first year of this program and the effort started on the second year program are reported.

24310 **Getting into hot water: the use of reject heat in aquaculture.** Nieves, L.; Wells, K. (Battelle Pacific Northwest Labs, Wash). *Commercial Fish Farmer;* 5: No. 2, 12-15(Jan 1979).

Several major factors that determine the feasibility of using reject heat in commercial aquatic facilities are reliability, water quality, temperature, and lack of pollutants. Although technology exists for overcoming special requirements of these factors, a system that uses reject heat will require more capital and management than a conventional system with lower output will require. A careful analysis of investment and operating costs is recommended. (1 drawing, 1 photo)

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 23460, 23461, 23462, 23463, 23464, 23465, 23466, 23467, 23468, 23469, 23470, 23471, 23472, 23475, 23478, 23481, 23482, 23484, 23485, 23486, 23487, 23488, 23489, 23490, 23491, 23492, 23493, 23494, 23495, 23496, 23497, 23498, 23499, 23500, 23501, 23502, 23503, 23504, 23505, 23506, 23507, 23508, 23509, 23510, 23511, 23512, 23516, 23517, 23542, 23647, 23832, 24035, 24461, 24462, 24621

24311 (METC/SP—79/10(Pt.2), pp 570-578) **Cement as admixture to fly ash concrete.** Akinc, M.; Fan, L.T. (Kansas State Univ., Manhattan). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The results indicate that a fly ash concrete mix containing 517 lb of untreated fly ash and 129 lb of portland type I cement is comparable to or better than concretes containing 470 lbs of portland type I cement at least in compressive and flexural strength. A comparison of the estimated costs of the two is given in a table. It shows that the fly ash/concrete mix saves as much as $3.67 per cubic yard of concrete. We have made fly ash/portland cement admix concrete design mixtures that compare with early strength and aging compressive strengths of portland cement concrete. The x-ray diffraction patterns indicated that fly ash concretes with admixtures hydrated properly forming calcium silicate hydrates while the ones without admixtures retained their original structure for a long time. Also, free lime observed in portland cement concretes was absent in the fly ash system. We believe that other durability tests will prove to be satisfactory. At this stage we can suggest that the fly-ash/cement admix concrete would be very well suited to applications where the environment is mild, or for massive structures with a thin regular face on it. The greater economic savings are attractive for immediate applications where the main concern is a predictable strength together with the technical improvements in the quality of the resultant concrete.

24312 (METC/SP—79/10(Pt.2), pp 784-786) **Slag: a useful form of ash.** Stark, I.A. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

24313 (METC/SP—79/10(Pt.2), pp 898-903) **Some effects of western coal fly ash on municipal sewage sludge.** Kincannon, D.F. (Oklahoma State Univ., Stillwater); Gaudy, A.F. Jr.; Scriminger, W.F.; Ricketts, W. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The paper presents the results of experimental work carried out by Oklahoma State University showing that subbituminous fly ash will immediately deodorize, sterilize and dry raw sewage sludge solids, producing a product useful as a soil conditioner because of its organic content, thus solving disposal problems of both constituents.

24314 (METC/SP—79/10(Pt.2), pp 938-939) **Title 15, United States Code, Section 2300: consumer product warranties. The Magnuson-Moss Warranty Act.** 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

24315 (PB—299919) **Environmental and resource conservation considerations of steel industry solid waste. Final report May 1978-February 1979.** Baldwin, V.H.; Branscome, M.R.; Allen, C.C.; Marsland, D.B.; Carpenter, B.H. (Research Triangle Inst., Research Triangle Park, NC (USA)). Apr 1979. Contract EPA-68-02-2612. 225p. NTIS, PC A10/MF A01.

The report examines the solid wastes generated by the iron and steel industry relative to the impact of Section 4004 of the Resource Conservation and Recovery Act. The quantities, properties, and origin of wastes which pose a potential problem are identified using flow diagrams, material balances, and generation factors. Of the estimated 140 million metric tons of solid waste (including inplant mill scrap) generated annually, 80% is either recycled or reused. Waste disposal practices are discussed, and the potential for groundwater pollution has been identified. The capital cost to collect leachate from nonhazardous wastes which could potentially endanger the groundwater was estimated to increase the current landfill costs by 40%; however, this cost was less than 1% of the estimated future overall environmental cost.

24316 (PB—300761) **Utilization of fly ash and coal mine refuse as a road base material. Final report 1973-77.** Wilmoth, R.C.; Scott, R.B. (Environmental Protection Agency, Cincinnati, OH (USA). Industrial Environmental Research Lab.). Aug 1979. 71p. NTIS, PC A04/MF A01.

The U.S. Environmental Protection Agency conducted a four-year study to determine the feasibility of using fly ash and coal mine refuse as a road base in a parking lot. The lot was divided into three areas each receiving the same surface treatment but wit different ratios of fly ash to refuse. Area 1 was composed of 75-percent coal mine refuse and 25-percent fly ash; Area 2 was composed of the same material as Area 1 with the addition of 5 percent by weight of lime; and. Area 3 consisted solely of coal mine refuse. All areas were periodically monitored and with the exception of Area 3 were found to be environmentally acceptable. Physical structural characteristics of the road base material indicated that these waste products can be successfully used as a base or subbase road material when properly compacted and/or stabilized.

24317 (PB—300763) **Evaluation of the ultraviolet-ozone and ultraviolet-oxidant treatment of pink water. Final report 6 June 1976-30 December 1977.** Roth, M.; Murphy, J.M. Jr. (Army Armament Research and Development Command, Dover, NJ (USA). Large Caliber Weapon Systems Lab.). Jul 1979. 41p. NTIS, PC A03/MF A01.

Pink water, a solution of trinitrotoluene (TNT) and other nitrobodies, is a major pollutant at ammunition plants engaged either in the manufacture of TNT or in the loading, assembly, and packing of bombs and shells. As an alternative to carbon adsorption for the treatment of pink water, two new methods are reported here, the first involving the use of ultraviolet (uv)-ozone and the second using a uv-oxidant combination. In the first study, a 3.79 cubic meters per day ((m sup 3)pd), equivalent to 1000 gallons per day (gpd), uv-ozone pilot system was evaluated. It was found that dissolved TNT and RDX were reduced to less than one milligram per liter (mg/l) with no by-products requiring disposal. A design for a 19 m3pd (5000 gpd) pilot plant was proposed. In the second study, a uv-oxidant process for treatment of pink water was examined. Commercially available uv water purification units in conjunction with an oxidant such as hydrogen peroxide or Oxone, (a blend of potassium persulfate oxidants), were evaluated for their efficiency in treating pink water. Variables such as film depth, dilution, uv wavelength, and operation of the units in series rather than in parallel were examined. A design for a 379 m3pd (100,000 gpd) pink-water treatment plant was proposed.

24318 (PB—300879) **The application of brown coal fly ash to road base courses. Final report.** Pachowski, J. (Polish Ministry of Transport, Warsaw. Road and Bridge Research Inst.). Sep 1979. 155p. NTIS, PC A08/MF A01.

The findings of this investigation indicate that stabilization of cohesive soils to obtain improved subgrades for all-purpose roads and better subbase for lightweight roads can be obtained with the use of reactive brown coal fly ash; the reactive ingredient in these fly ashes, viz., free lime, can vary from seven to over twenty percent by weight. Stabilization of non-cohesive soil can be accomplished with usage of both reactive and unreactive fly ashes with corresponding decreases in cement requirements with no significant technical problems. The production of fly ash concrete necessitates closer and more detailed investigation of the role of non-reactive fly ash in concrete. An investigation of the use of nonreactive, brown coal fly ash as a filler in portlad cement concrete and bituminous mixes for road embankments is also recommended. In Poland, the use of fly ash in road construction has helped bring improvement and greater safety in motor transport, economic savings in costs, improved working and living conditions due to lessening in pollution and improving the appearance of the environment.

24319 (SAN—1701-T1) **Industrial recovered-materials-utilization targets for the rubber industry. Final report.** (Hittman Associates, Inc., Columbia, MD (USA)). 1979. Contract EC-77-C-03-1701. 275p. Dep. NTIS, PC A12/MF A01.

Targets for utilization of energy-saving recovered materials within the rubber-products industry are presented along with the documentation supporting these proposed targets. The recovered material used in this industry is termed recovered rubber (RR), and includes reclaimed (devulcanized) scrap rubber, and waste rubber products that have been retreaded (tires) or slit into useful items. Reclaimed and ground scrap rubber are used either as a replacement for virgin rubber or as a filler material in the manufacturing of new products. While reclaimed rubber is much more widely used than ground scrap, often they are interchangeable. There is a trade-off of physical characteristics which much be considered in choosing between use of reclaimed rubber and ground scrap; however, the overriding consideration is usually economic. As ground scrap becomes more economically attractive due to recent advances in grinding

technologies, it will command a larger share of the market for recovered rubber. The rubber industry has been subdivided according to the Standard Industrial Classification system (SIC) four-digit code level. Targets have been developed for each subdivision that has potential for utilizing RR.

24320 Utilizing bark and wood residues to solve technical problems. Mater, J. (ed.). Madison, WI; Forest Products Research Society (1978). 106p. (CONF-770776—).

From Forest products research society annual meeting; Denver, CO, USA (7 Jul 1977).

Some technical problems solved by utilizing bark and wood residues are discussed. Separate abstracts are prepared for individual items. (DC)

MUNICIPALITIES AND COMMUNITY SYSTEMS

REFER ALSO TO CITATION(S) 24251

24321 (PB—301109) **Overall city technology process. Final report.** Jhaveri, A.G.; Jones, C. (Seattle Office of Management and Budget, WA (USA)). Apr 1979. 31p. NTIS, PC A03/MF A01.

The Overall City Technology Process (OCTP) intends to bring state-of-the-art science and technology to bear on City problems and to integrate the technology transfer process into the City's regular decision-making process. First year achievements included the integration of the technology assessment and application process into the City's Annual Budget process and the involvement of significant City staff in technology assessment, priority setting, and application activities. Second year objectives were to follow through on previous specific projects and to concentrate application of innovative technology in two specific areas: municipal energy conservation and program performance measurement. These are among the City's high priority management initiatives. Seattle's two-year experience with the OCTP Project revealed that: (1) technology improvement proposals must match the City's general policy and budget priorities; (2) review of these proposals must be integrated with the existing decision-making process; (3) collection and dissemination of technology information should be centralized within the City; (4) the national communication network regarding innovative technology is ineffective at the local level; and (5) the City of Seattle has benefited from the implementation of the OCTP Project.

PUBLIC UTILITIES

REFER ALSO TO CITATION(S) 24189

24322 (COO—4975-(Vol.1)(Text)) **District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume I. Text.** (Detroit Edison Co., MI (USA)). 15 Sep 1979. Contract EM-78-C-02-4975. 361p. NTIS, PC A16/MF A01.

An analysis was performed investigating the potential of retrofitting Detroit Edison's Conners Creek power plant to supply district heating and cooling to an area surrounding the plant and within the City of Detroit. A detailed analysis was made of the types and ages of the buildings in the service area as a basis for establishing loads. The analysis of the power plant established possible modifications to the turbines to serve the load in the area. Based upon the service area data and plant retrofit schemes, a distribution system was developed incrementally over a 20-y period. An economic analysis of the system was performed to provide cash flows and payback periods for a variety of energy costs, system costs, and escalation rates to determine the economic viability of the system analyzed. The legal and regulatory requirements required of the district heating and cooling system owner in Michigan were also analyzed to determine what conditions must be met to own and operate the system.

24323 (COO—4980-1) **District heating and cooling system for communities through power plant retrofit and distribution network. Final report, Phase I.** (Minnesota Energy Agency, St. Paul (USA)). Jun 1979. Contract EM-78-C-02-4980. 301p. NTIS, PC A14/MF A01.

The technical and economic feasibility of retrofitting thermal power plants in Minnesota to accommodate both heat and power generation for district heating was examined and is discussed. Three communities were identified as viable sites for co-generation district heating. (LCL)

24324 (COO—4980-1(Exec.Summ.)) **District heating and cooling through power plant retrofit and distribution network. Final report. Phase 1, executive summary.** (Minnesota Energy Agency, St. Paul (USA)). 1979. Contract EM-78-C-02-4980. 19p. NTIS, PC A02/MF A01.

The technical and economic feasibility of retrofitting thermal power plants in Minnesota so as to produce both electricity and heat for district heating systems is discussed. Three communities are identified as viable sites for co-generation district heating. (LCL)

24325 (COO—4975-1(Vol.2)(App.)) **District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume II. Appendices.** (Detroit Edison Co., MI (USA)). 15 Sep 1979. Contract EM-78-C-02-4975. 168p. NTIS, PC A08/MF A01.

This appendix presents tabulated data used for evaluating the feasibility of retrofitting thermal power plants in the Detroit area so as to provide heat for a district heating system. (LCL)

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 24648

24326 (PB—299753) **A pollution-free system for the economic utilization of municipal solid waste, task 10, electrochemical recovery of non ferrous metals derived from municipal refuse.** Szostak, R.M.; Linford, H.B.; Schulz, H.W. (Columbia Univ., New York (USA). School of Engineering and Applied Science). 15 Apr 1976. 64p. NTIS, PC A04/MF A01.

Processes are developed to recover the major components of municipal refuse, particularly aluminum, zinc, and copper. The economic and engineering feasibility of electrochemical recovery was determined. The proposed method included ferrofluid levitation, electrolytic refining, and metal salt recovery. Ferrofluid levitation separated non-ferrous metals of different densities by floating less dense objects in a pool of magnetic liquid. A magnetic field is applied to the liquid to produce a levitation force in opposition to the normal gravitional force. Aluminum and zinc alloys are thus recovered in granular form. Electrolytic refining recovers copper as cathode bars. The copper-rich fraction from the ferrofluid levitation is cast into anodes and then electrolytically deposited as pure cathode copper. A dilute solution of sulfuric acid is used as the electrolyte in a cell of conventional design. The metal salt recovery process comprises a pH controlled precipitation of the metal salts and subsequent filtration. Studies show that copper is deposited as a high-grade cathode when the electrolyte contains 75 grams/liter of sulfuric acid and a limited quantity of metal impurities. Economic studies, based on a copper alloy feed rate of 100 tons/day, have indicated that the electrochemical recovery of aluminum, zinc, and copper is a cost-effectiveness means of metal production.

24327 (PB—300465) **A pollution-free system for the economic utilization of municipal solid waste for the city of new york. phase i. a critical assessment of advanced technology. I. Thermal oxidation processes. II. Biochemical conversion processes. III. Refuse collection technology. IV. Reclamation and recycling.** Schultz, H.W.; Neamatalla, M.; Tong, G.; Young, M. (Columbia Univ., New York (USA). School of Engineering and Applied Science). 15 Jun 1973. 134p. NTIS, PC A07/MF A01.

As background for a study to develop an integrated system for the pollution-free utilization of the municipal refuse generated by New York City with optimum recovery of energy and useful products, four position papers have been prepared to assess advanced technology applicable to solid waste management. Topics examined are thermal oxidation processes, biojchemical conversion processes, refuse collection technology, and reclamation and recycling. This report includes these papers, focusing on the most promising alternatives in each category and placing emphasis on comparative economics and technical practicality. The various processes and technologies of each paper are described in considerable detail.

24328 (PB—300523) **Refractory particles in cullet recovered from municipal refuse. Technical report.** Duckett, E.J. (National Center for Resource Recovery, Inc., Washington, DC (USA)). Mar 1979. 46p. NTIS, PC A03/MF A01.

A potential new source of cullet for container manufacture is the galss contained in municipal solid waste (MSW). However, this cullet may be contaminated with particles of refractory materials which may survive a container glass furnace and cuase stone formations in the bottles. This report addresses the problem of refractory contamination as a potential barrier to the increased use of glass recovered from MSW. It reviews the causes of stones in container glass; the nature of the refractory particles found in cullet recovered from MSW; the behavior (both expected and observed) of refractory particles in the glass furnace; and some approaches available for either removing refractory particles from the recovered cullet or minimizing the effects of the refractory contaminants.

24329 (PB—300848) **Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation. Volume II. working papers.** (Office of Technology Assessment (U.S. Congress), Washington, DC). Jul 1978. 529p. NTIS, PC A23/MF A01.

This volume contains the complete texts of three working papers prepared by contractors in support of the assessment of resource recovery, recycling and reuse from municipal solid waste. These papers are; (1) Market Prognosis: Recyclable Goods Available from Municipal Solid Waste; (2) Effect of Freignt Rates on the Movement and Sale of Selected Recyclable Commodities; (3) Evaluation of Policy Issues in Resource Recovery: An Application of Recovery and Market Planning (RAMP).

24330 (PB—300849) **Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation.** (Office of Technology Assessment (U.S. Congress), Washington, DC). Jul 1979. 289p. NTIS, PC A13/MF A01.

This report addresses important questions that have arisen about the feasibility of various approaches to resource recovery, recyling, and reuse. It presents the results of an examination of important technical, economic, and institutional factors. Federal policies that might stimulate resource recovery, recycling, and reuse were identified and their effectiveness and impacts were assessed. The criteria used for assessing the policy options include technical and administrative feasibility (effectiveness), economic efficiency, equity, risk reduction, and diversity.

24331 (SAND—80-0989C) **Dried, irradiated sewage solids as supplemental feed for cattle.** Smith, G.S.; Kiesling, H.E.; Ray, E.E.; Orcasberro, R.; Trujillo, P.; Herbel, C.H. (New Mexico State Univ., Las Cruces (USA); Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 37p. (CONF-7905103—2). NTIS, PC A03/MF A01.

From Energy technology conference on waste irradiation; Hanover, F.R. Germany (2 May 1979).

Sewage solids were collected as primary settled solids and then dried and gamma-irradiated (using ^{60}Co or ^{137}Cs) to absorbed dosage of about one megarad to minimize viable parasites and pathogenic organisms. Nutrient composition and bioassays with rumen microbes suggested prospective usage as supplemental feed for ruminants. Short-term experiments with sheep and then with cattle further suggested that usage of nutrients could be beneficial and that accumulation of heavy metals was not excessive. A longer-term feeding trial with cattle fed sewage solids as 20% of diet for 68 days demonstrated that tissue uptake of elements such as Cu, Fe and Pb was measurably increased, but not sufficient to exceed ranges considered normal. Likewise, of 22 refractory organic compounds having toxicological interest, only a few were detectible in adipose tissue and none of these exceeded levels that have been reported in tissues from cattle produced conventionally. In a large-scale experiment, beef cows grazing poor-quality rangeland forage during late gestation-early lactation were given either no spplemental feed or cottonseed meal or experimental supplement comprised of 62% sewage solids. Supplements were provided for 13 weeks until rangeland forage quality improved seasonably. Supplemental cottonseed meal for cows improved weaning weights of calves by about 11% over unsupplemented controls; whereas, supplement with 62% sewage solids improved calf weaning weights by about 7%. Hazards or risks to animals or to human health appear to be slight when sewage solids of this type are fed as supplemental feeds to cattle in production programs of this type.

EDUCATION AND PUBLIC RELATIONS

REFER ALSO TO CITATION(S) 24191

24332 (DOE/IR/0033—T2) **Educational and demographic characteristics of energy-related scientists and engineers, 1976.** Finn, M.G.; Bain, T. (Oak Ridge Associated Universities, Inc., TN (USA)). Apr 1980. Contract EY-76-C-05-0033. 39p. NTIS, PC A03/MF A01.

This analysis of the education, training, and age distribution of experienced scientists, engineers, energy-related scientists, and energy-related engineers uses the 1976 National Science Foundation National Sample data on 50,000 scientists and engineers who were in the labor force at the time of the 1970 Census. The energy-related scientists and engineers have characteristics quite similar to those of all scientists and engineers. However, energy-related scientists and engineers report slightly higher educational attainment as well as a higher incidence of supplemental training. Energy-related engineers generally are not much older than their counterparts who did not report energy-related work. Energy-related scientists, however, are older than their counterparts and can be expected to experience losses from death and retirement at a rate about 12% higher than the rate for all scientists over the next decade.

24333 (DOE/OR/00033—T1) **Energy-related scientists and engineers: a statistical profile of recent entrants into the work force, 1978.** Bell, S.E. (Oak Ridge Associated Universities, Inc., TN (USA)). Dec 1979. Contract EY-76-C-05-0033. 156p. NTIS, PC A08/MF A01.

This report examines the educational and employment characteristics of scientists and engineers who graduated during the years 1972, 1974, 1975, and 1976, with special attention to those whose work involves energy. The characteristics of energy-related graduates are also compared to those of more experienced scientists and engineers involved in energy activities. Information is based on the results of the 1976 and 1978 National Surveys of Recent Science and Engineering Graduates, and the 1976 National Survey of Natural and Social Scientists and Engineers, sponsored by the National Science Foundation and the US Department of Energy. Tabulations are included for the first time on employment involving specific energy sources and activities. Other characteristics discussed include educational level, salary, primary work activity, type of employer, and the proportion of graduates who found employment in their major field.

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 24340, 24341

24334 **Comparison of alternate power sources for the MX missile system.** Noren, D.V. (TRW Defense and Space Systems Group, San Bernardino, CA). pp 45-47 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

Various technologies were reviewed to identify power sources which best meet the MX requirements. Since energy can be stored in mechanical, chemical, thermal or electrochemical form, the technologies investigated were flywheels, heat engines, fuel cells and batteries. The characteristics of each of these systems are discussed. Progress in Phase I of the two MX Advanced Development Programs has shown that nickel-zinc batteries appear to be a viable and more cost-effective replacement for the silver-zinc batteries which were tentatively baselined for MX and, with further development, lithium-thionyl chloride batteries, when combined with some nickel-zinc batteries for the pre-attack outages, may better satisfy the overall MX requirements. (LCL)

SPARK-IGNITION

REFER ALSO TO CITATION(S) 24357, 24358

DIESEL

REFER ALSO TO CITATION(S) 24351, 24520

24335 (CONS—3288-T6) **Performance of a diesel engine operating on raw coal-diesel fuel and solvent refined coal-diesel fuel slurries. Final report.** Marshall, H.P. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Mar 1980. Contract ET-78-S-01-3288. 129p. NTIS, PC A07/MF A01.

Performance tests using an 11 kW single cylinder diesel engine were made to determine the effects of three different micronized coal-fuel oil slurries being considered as alternative fuels. Slurries containing 20, 32, and 40%-wt micronized raw coal in No. 2 fuel oil were used. Results are presented indicating the changes in the concentrations of SO/sub X/ and NO/sub X/ in the exhaust, exhaust opacity, power and efficiency, and in wear rates relative to operation on fuel oil No. 2. The engine was operated for 10 h at full load and 1400 rpm on al fuels except the 40%-wt slurry. This test was discontinued because of extremely poor performance.

24336 (TE—4234-37-80) **Economic and technological assessment of diesel engines using coal-based fuels for electric power generation. Final report.** Dunlay, J.B.; Davis, J.P.; Maslen, P.L.; Steiger, H.A.; Eberle, M.K. (Thermo Electron Corp., Waltham, MA (USA)). Sep 1979. Contract EF-77-C-01-2647. 233p. Dep. NTIS, PC A11/MF A01.

The slow-speed, two-stroke diesel engine operating on coal-based fuels is a promising power conversion system for electric power generating plants and for industrial cogeneration applications. The coal-based diesel system is a near-term technology which can encourage the use of coal fuels and achieve substantial energy savings. This report describes: experimental engine performance data on representative coal-based fuels, economics of typical system installations, and development requirements to make the system commercially available. The program results indicate that current slow-

speed, two-stroke diesel engine technology can be adapted, with minimum development, for coal-derived liquid fuels in order to establish an efficient power system with multifuel capabilities and wide applicability. Engine test results on two coal-derived liquid fuels (COED and SRC-II) are included in this report. The slow-speed, two-stroke diesel engine performs very well on both fuels. The results of continuing tests on micronized coal/oil slurry will be reported in a separate document. Preliminary results of the slurry tests indicate that coal in the form of micronized particles is also a satisfactory fuel for the slow-speed, two-stroke diesel engine if adequate provisons are made for fuel injection and ash related wear.

TURBINE

24337 (DOE/NASA/1040—80/14) **Effect of catalyst length and downstream reaction distance on catalytic combustor performance.** Anderson, D. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1980. Contract EC-77-A-31-1040. 26p. (NASA-TM—81475). Dep. NTIS, PC A03/MF A01.

A study was made to determine the effects on catalytic combustor performance which resulted from independently varying the length of a catalytic reactor and the length available for gas-phase reactions downstream of the catalyst. Monolithic combustion catalysts from three manufacturers were tested in a combustion test rig with No. 2 diesel fuel at an inlet-air temperature of 1000°K, a pressure of 3 x 10^5 Pa, reference velocities of 10 and 15 m/s, and adiabatic combustion temperatures of 1200 to 1500°K. Catalytic reactor lengths of 2.5 and 5.4 cm, and downstream gas-phase reaction distances of 7.3, 12.4, 17.5, and 22.5 cm were evaluated. Measurements of carbon monoxide, unburned hydrocarbons, nitrogen oxides, and pressure drop were made. The catalytic-reactor pressure drop was less than 1 percent of the upstream total pressure for all test configurations and test conditions. Nitrogen oxides and unburned hydrocarbons emissions were less than 0.25 g NO_2/kg fuel and 0.6 g HC/kg fuel, respectively. The minimum operating temperature (defined as the adiabatic combustion temperature required to obtain carbon monoxide emissions below a reference level of 13.6 g CO/kg fuel) ranged from 1230°K to 1500°K for the various conditions and configurations tested. The minimum operating temperature decreased with increasing total (catalytic-reactor-plus-downstream-gas-phase-reaction-zone) residence time but was independent of the relative times spent in each region when the catalytic-reactor residence time was greater than or equal to 1.4 ms.

24338 (DOE/NASA/9416—80/2) **Durability testing at 5 atmospheres of advanced catalysts and catalyst supports for gas turbine engine combustors.** Olson, B.A.; Lee, H.C.; Osgerby, I.T.; Heck, R.M.; Hess, H. (Engelhard Minerals and Chemicals Corp., Edison, NJ (USA). Engelhard Industries Div.). Apr 1980. Contract EF-77-A-01-2593. 93p. (NASA-CR—159839). NTIS, PC A05/MF A01.

Studies were conducted under a NASA contract funded by DOE to experimentally demonstrate the durability of conclusion ATCOM catalysts and catalyst supports in a combustion environment under simulated gas turbine engine combustor operating conditions. A test of 1000-hours duration was completed with one catalyst using No. 2 diesel fuel and operating at catalytically-supported thermal combustion conditions. This five-atmosphere pressure durability test was conducted using an air-preheat temperature of about 640°K and a reference velocity of about 14 meters/second. The adiabatic flame temperature of the fuel/air mixture was 1533°K. The performance of the catalyst was determined by monitoring emissions throughout the test, and by examining the physical condition of the catalyst core at the conclusion of the test. Tests were performed periodically to determine changes in cataytic activity of the catalyst core. Detailed parametric studies were also run at the beginning and end of the durability test, using No. 2 fuel oil. Initial and final emissions for the 1000-hours test respectively were: unburned hydrocarbons (C_6 vppm): 0, 146; carbon monoxide (vppm): 30, 2420; nitrogen oxides (vppm): 5.7, 5.6.

24339 **Ram air turbine power supplies for high performance flight vehicles.** Braendlein, R.K.; McGlone, R.B.; Wood, J.L. (Marquardt Co., Van Nuys, CA). pp 64-66 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

There is considerable interest and activity in ram air turbine power supplies for high performance flight vehicles. This interest is evidenced by the three programs currently underway at Marquardt, which span the development spectrum from design (Firebrand RGP) to ground test development/demonstration (ASALM FVPS) to flight test (HAST DPU). These applications all have common requirements for high efficiency and minimum volume packaging. Using these applications as an indication, the trend in ram air power supply technology is toward high speed/high efficiency turbines and pumps and rare earth (samarium cobalt) generators to maximize power output with minimum weight and volume components.

EXTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 24334

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 24266

24340 (ATR—79(7759)-1(Vol.3)) **Study of hydrogen-powered versus battery-powered automobiles.** Donnelly, J.J. Jr.; Greayer, W.C.; Nichols, R.J.; Escher, W.J.D. (Escher Technology Associates, St. Johns, MI (USA); Aerospace Corp., El Segundo, CA (USA). Eastern Technical Div.). May 1979. Contract EM-78-C-03-2184. 225p. Dep. NTIS, PC A10/MF A01.

A study conducted to compare the technological status and the resultant potential vehicle characteristics for hydrogen- and battery-powered automobiles that could be produced from 1985 to 2000 is documented in 3 volumes. The primary objectives of the study were: the assessments of applicable energy storage and propulsion technology for the two basic vehicle types (applied to four-passenger cars); a rigorous comparison of vehicle weight, size, and usefulness versus design range; and an investigation of the relative efficiencies of expending energy from various primary sources to power the subject vehicle. Another important objective, unique to hydrogen powered vehicles, was the assessment of the technology, logistics, and cost implications of a hydrogen production and delivery capability. This volume, Volume III, contains three major sections: the assessment of battery electric vehicle technology for energy storage and the drivetrain system; the technical and economic comparison of hydrogen- and battery-powered vehicles derived primarily from data in the previous vehicle technology assessments, with consideration of alternative energy sources; and a series of appendices that support the vehicle definitions and comparisons.

24341 (ATR—79(7759)-(Vol.2)) **Study of hydrogen-powered versus battery-powered automobiles.** Donnelly, J.J. Jr.; Greayer, W.C.; Nichols, R.J.; Escher, W.J.D. (Escher Technology Associates, St. Johns, MI (USA); Aerospace Corp., El Segundo, CA (USA). Eastern Technical Div.). May 1979. Contract EM-78-C-03-2184. 341p. Dep. NTIS, PC A15/MF A01.

A study conducted to compare the technological status and the resultant potential vehicle characteristics for hydrogen- and battery-powered automobiles that could be produced from 1985 to 2000 is documented in 3 volumes. The primary objectives of the study were: the assessments of applicable energy storage and propulsion technology for the two basic vehicle types (applied to four-passenger cars); a rigorous comparison of vehicle weight, size, and usefulness versus design range; and an investigation of the relative efficiencies of expending energy from various primary sources to power the subject vehicles. Another important objective, unique to hydrogen-powered vehicles, was the assessment of the technology, logistics, and cost implications of a hydrogen production and delivery capability. This volume, Volume II, provides an introduction to the study and two major sections applicable to hydrogen-powered vehicles - the study of hydrogen production and delivery alternatives before the year 2000 and the assessment of automotive technology for hydrogen storage and use in internal combustion engines.

24342 (CONS—4209-T1(Vol.10)) **Hybrid vehicle potential assessment. Volume 10. Electric and hybrid vehicle cost handbook.** Heft, R.C.; Heller, S.C. (Jet Propulsion Lab., Pasadena, CA (USA)). 30 Sep 1979. Contract EM-78-I-01-4209. 77p. Dep. NTIS, PC A05/MF A01.

The purpose of this interim cost handbood is to provide a consistent single-point source of data and procedures for estimating the costs of electric and hybrid vehicles. These costs include manufacturing, acquisition (purchase price), operating, and life cycle. Each suggested Cost Estimating Relation (CER) presented herein is a result of the compilation of currently existing cost estimates and cost relationships. No independent cost analysis was performed for this handbook, nor was any analysis performed to rework existing cost data for consistency in all primary assumptions. The cost data is presented in terms of major component and subassembly costs so that any vehicle (electric, hybrid, or conventional) can be costed. The cost estimating relations presented in this handbook are subjective averages of the several independent estimates for each component.

24343 (PB—299746) **Agt guideway and station technology. Volume 8. Weather protection concepts. Final report.** Stevens, R.D.; Nicarico, T.J.; McGean, T.J.; Easley, S.M.; Easley, T.L. (De Leuw,

Cather and Co., Chicago, IL (USA)). Aug 1979. Contract DOT-UT-70066. 249p. NTIS, PC A11/MF A01.

The objective of the project is to develop guideway, station, and weather protection concepts which will reduce the cost and implementation time associated with AGT systems as well as to improve performance. In Volume 8, weather protection concepts are presented for guideways associated with AGT systems, with emphasis on minimizing costs and energy consumption while maximizing system operability/reliability during winter weather. The concepts include a comparison of embedded pipe and electric heating systems with varied heated widths, heating densities, and amount of utilization.

24344 (PB—300289) **Analysis of life-cycle costs and market applications of flywheel energy-storage transit vehicles. Final report 1977-78.** Goeddel, D.L.; Ploetz, G. (Department of Transportation, Cambridge, MA (USA). Transportation Systems Center). Jul 1979. 180p. NTIS, PC A09/MF A01.

The Urban Mass Transportation Administration (UMTA) has recently completed the Phase I activities of its Flywheel Energy Storage Program involving an analysis of the operational requirements and the conceptual design of flywheel energy storage vehicles for transit service. Flywheel energy storage systems are being proposed as a means of reducing the energy requirements of fixed-route, multi-stop, urban transit vehicles. The Phase I studies have paved the groundwork for the succeeding program phase which include the design, fabrication, test, and evaluation of prototype flywheel vehicle systems for demonstrations in transit service. As part of the overall program, UMTA has requested the Transportation Systems Center (TSC) to conduct an independent assessment of the life cycle costs and the potential market applications of flywheel storage vehicles within the urban transit industry. This report documents the results of these analyses. It examines the economic viability and the potential market applications of these proposed concepts within urban transit operations. The report presents a description of the structure, the approach, and the assumptions of the analysis; defines the design characteristics, the system capital costs, and the annual recurring operations/maintenance costs associated with the conventional diesel bus, the trolly bus, and the three flywheel-powered vehicle systems considered in the study; describes the results of the life-cycle analysis and the sensitivity of these results due to variations of key assumed input variables; and discusses the potential demand and the market applications of flywheel energy storage vehicles within transit service operations.

24345 (PB—300306) **Simulation of an urban battery bus vehicle. Final report June-December 1978.** Stickler, J.J. (Department of Transportation, Cambridge, MA (USA). Transportation Systems Center). Jul 1979. 89p. NTIS, PC A05/MF A01.

This report describes the computer simulation of a battery-powered bus as it traverses an arbitrary mission profile of specified acceleration, roadway grade, and headwind. The battery-bus system components comprise a DC shunt motor, solid-state power conditioning unit with regeneration capability, and a battery source consisting of a multi-unit lead acid battery. The computer model determines vehicle tractive effort and power consumption and computes actual vehicle speed for a given mission profile. The program output data is tabulated in a form which allows easy recognition of the various operational modes and power-limited regimes. The computer model uses a 'modularization' format which facilitates the simulation of alternate propulsion systems involving the interchange of one system component for another. The model is applied to simulate the propulsion characteristics of a typical bus operating over a specified drive cycle. The results of this study demonstrate the applicability of the battery bus model for predicting bus propulsion characteristics under simulated drive conditions. This report provides charts depicting the plotting program, input data required by the Battery Bus Performance Program, Fortran source listings and data files, as well as a Glossary of Prog

24346 (PB—300373) **Vehicle longitudinal control and reliability project. A review of AGT propulsion, power conditioning, braking and power distribution technology. Final report.** Schumacher, P. (Otis Elevator Co., Denver, CO (USA). Transportation Technology Div.). Jun 1979. Contract DOT-UT-70048. 78p. NTIS, PC A05/MF A01.

The report assesses the current state of the art of each technology. The review was performed to obtain top level information that can be used by system designers, specification writers, and regional planners as baseline considerations. The main sections of this report are: Section 2 discusses propulsion motor technology. It concludes information on both dc and ac motors; Section 3 discusses power conditioning options for converting guideway power to a suitable form for the motor being used; Section 4 presents the findings on electrical and mechanical braking; and Section 5 sets forth some power distribution and collection considerations.

24347 (PB—300918) **Energy storage propulsion system for rapid transit cars. Test results and system evaluation. Final report.** Raskin, D. (Metropolitan Transportation Authority, New York (USA)). Oct 1978. 136p. NTIS, PC A07/MF A01.

The principal objectives of this test program were to evaluate the ability of the Energy Storage (ES) System to: reduce propulsion energy usage; reduce propulsion power demands; and reduce tunnel heating caused by propulsion energy use. This report describes the test and evaluation of the ES system for rapid transit cars. The characteristics of the system were investigated in the real world by installing the novel equipment under two New York City subway cars and operating the cars both under test track conditions and in revenue service on several lines of the New York City Transit System. Tunnel heating effects, power reduction, gyroscopic forces, and other characteristics were investigated and evaluated. Overall propulsion energy reductions of 14-26%, as compared with conventional equipment, were measured in revenue service operations. Further reductions should be attainable by this system, if improvements derived from this test program were to be incorporated into the equipment and control configuration. The authors state that the equipment tested under the two R-32 cars demonstrated that onboard flywheel energy storage is an impressive means for achieving major savings in transit car propulsion energy. Part II of this report describes the methods for applying the energy conservation data to rapid transit systems other than New York's. Appendixes are provided which give specific information on the New York subway routes and on the instrumentation used.

24348 (UCRL—15241) **Control system considerations for an aluminum-air battery powered electric vehicle. Final report.** Cox, L.E.; Hassman, G.V.; Post, S.F. (Brobeck (William M.) and Associates, Berkeley, CA (USA)). 15 May 1980. Contract W-7405-ENG-48. 35p. NTIS, PC A03/MF A01.

The study established basic motor-controller requirements and trade-offs between 30-cell and 60-cell aluminum-air battery systems. A sample controller design was evolved and basic characteristics were evaluated. Advantages of a 60-cell battery system over a 30-cell were found in the areas of control system costs, weights, and efficiency.

HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 24234, 24342, 24347

24349 (CONS—4209-T1(Vol.5)) **Electric and Hybrid Vehicle System Research and Development Project: hybrid vehicle potential assessment. Volume V. Flywheel systems.** Liddle, S.G. (Jet Propulsion Lab., Pasadena, CA (USA)). 30 Sep 1979. Contract EM-78-I-01-4209. 91p. NTIS, PC A05/MF A01.

The design, operation and calculated performance of a flywheel-electric hybrid vehicle are discussed. Seven different operating strategies are considered. The calculation procedures are described. The results are plotted. (LCL)

FLYWHEEL PROPULSION

REFER ALSO TO CITATION(S) 24349

24350 **Hydrobus, gyrobus use brake-generated energy.** Scott, D. *Pop. Sci.;* **216**: No. 4, 76-77(Apr 1980).

M.A.N. of Munich is developing a hydrobus concept, involving hydraulic pressure as the storage medium, and a gyrobus system with flywheel energy storage. Mercedes-Benz is also working on a gyrobus design. The hydraulic storage regenerative-braking design and the flywheel storage in the gyrobus are explained.

EMISSION CONTROL

REFER ALSO TO CITATION(S) 24335, 24338, 24599

24351 (PB—299928) **Investigation of the effects of the installation of an oxidation catalyst on a diesel powered vehicle. Technical report.** Barth, E.A. (Environmental Protection Agency, Ann Arbor, MI (USA)). Mar 1979. 20p. NTIS, PC A02/MF A01.

The increased importance of diesels has caused a significant amount of discussion as to the ability of the manufacturers to meet the recently announced EPA Diesel Emission standards. Since there was little or no experience with the effects of installing an oxidation catalyst in a Diesel-powered vehicle, the EPA decided to investigate this configuration for its effects on both regulated and unregulated pollutants. Due to the relatively low hydrocarbon and carbon monoxide emissions typical of Diesel exhaust the initial question was whether the catalyst would attain a sufficient temperature to allow it to function as intended. The conclusions drawn from this EPA

evaluation test can be considered to be qualitatively and quantitatively valid only for the specific vehicle and catalyst used. After establishing that the catalyst would function, its effect on emissions, both gaseous and particulate, on fuel economy and on vehicle performance were to be investigated.

24352 (PB—300304) **Motor vehicle emissions inspection/maintenance program for South Carolina. Final report.** Gunderson, J.; Vodonick, E.J.; Pan, G.; Clark, D.D.; Gatacre, J. (Systems Control, Inc., Anaheim, CA (USA). Environmental Engineering Div.). Feb 1979. Contract EPA-69-02-2536. 39p. NTIS, PC A03/MF A01.

This report presents an analysis of alternative motor vehicle basic inspection and maintenance programs in terms of related costs and benefits for the State of South Carolina with specific information covering Lexington, Richland, Charleston, and Berkley Counties. The study methodology used is described and includes collecting data, determining criteria for selecting alternative program configuration, screening program option and evaluating alternative configuration selected through the screening process. Program alternatives were evaluated in terms of emission reduction attainable, geographic coverage, effective motor vehicle populaton, consumer protection, quality assurance, costs and financial feasibility.

24353 (PB—301162) **Evaluation of motor vehicle emissions inspection and maintenance programs in Minnesota. Final report.** Midurski, T.P.; Sellars, F.M.; Roy, N.K.; Vlasak, D.L. (GCA Corp., Bedford, MA (USA). GCA Technology Div.). Feb 1979. Contract EPA-68-02-2887. 150p. NTIS, PC A07/MF A01.

Recent data for the State of Minnesota indicate that the National Ambient Air Quality Standards for CO and NO/sub x/ will not be attained in all areas of the State by 1982, even if all reasonable available control technologies are applied. In view of this, it is likely that the State will request from U.S. EPA an extension of the compliance date beyond 1982. In order for this request to be considered, the state must, among other things, have adopted a firm schedule for implementing a motor vehicle inspection and maintenance (I/M) program in the highly urbanized non-attainment areas. In this connection, the State of Minnesota is currently planning for the implementation of an I/M program. As a part of this effort, detailed analyses have been performed of the costs, personnel requirements, rationale for selecting the particular option, scheduling requirements, and effects that the cold climate in Minnesota might have on emission testing associated with the particular program option being considered. This document reports these analyses.

24354 (PB—301215) **Questions and answers concerning the technical details of inspection and maintenance. Technical report.** (Environmental Protection Agency, Ann Arbor, MI (USA). Inspection and Maintenance Staff). Apr 1979. 41p. NTIS, PC A03/MF A01.

The report includes questions and answers broken down into categories of benefits, costs and implementation of the details of inspection and maintenance. Issues discussed are emission reductions, maintenance costs, repairs, cost analysis, economic and social impact, vehicle/engine life, loaded/idle tests, heavy duty inspection/maintenance, funding, delays, public information, emission control devices (catalysts), (fuel switching), (physical inspection), mechanics training, warranty, and EPA reports and rules.

24355 (PB—301224) **Three point program to reduce fuel consumption, traffic congestion, and air pollution - status report (connecticut).** (Connecticut Dept. of Transportation, Wethersfield (USA). Div. of Mass Transit Planning). Jul 1975. 22p. NTIS, PC A02/MF A01.

The report presents information concerning the Three Point Program to reduce fuel consumption, traffic congestion, and air pollution. The three points of the program are as follows: Foster carpooling and charter express bus service (bus pooling) in private industry through the use of the Department's Computer consultation services; Construct additional interchange parking facilities to facilitate carpooling; and Develop additional express commuter bus service between surburban areas and the central business districts of Connecticut cities.

24356 (PB—301410) **Diesel hydrocarbon measurement - series filter test. Technical report.** Danielson, E. (Environmental Protection Agency, Ann Arbor, MI (USA)). Mar 1978. 13p. NTIS, PC A02/MF A01.

Filters were loaded by driving various cycles (FTP, LA-4 and 50 mph SS) and collecting the particulate materials. Wet filters are those on which particulate was collected and no drying steps were taken. Dry filters were prepared by baking wet filters at 380 F for one hour. Two different particulate collection systems were used for loading the second filter. One was in isokinetic particulate collection device designed to collect a large volume of diesel exhaust and is called a high volume sampler. The other was the existing Scott filter holder and heated probe set-up which is used to sample exhaust from the dilution tunnel.

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 24340, 24341

24357 (SAN—1212-T1) **Hydrogen engine performance analysis project. Second annual report.** Adt, R.R. Jr.; Swain, M.R.; Pappas, J.M. (Miami Univ., Coral Gables, FL (USA); Hawthorne Research and Testing, Inc., Coral Gables, FL (USA)). Jan 1980. Contract EC-77-C-03-1212. 469p. Dep. NTIS, PC A20/MF A01.

Progress in a 3 year research program to evaluate the performance and emission characteristics of hydrogen-fueled internal combustion engines is reported. Fifteen hydrogen engine configurations will be subjected to performance and emissions characterization tests. During the first two years, baseline data for throttled and unthrottled, carburetted and timed hydrogen induction, Pre IVC hydrogen-fueled engine configurations, with and without exhaust gas recirculation (EGR) and water injection, were obtained. These data, along with descriptions of the test engine and its components, the test apparatus, experimental techniques, experiments performed and the results obtained, are given. Analyses of other hydrogen-engine project data are also presented and compared with the results of the present effort. The unthrottled engine vis-a-vis the throttled engine is found, in general, to exhibit higher brake thermal efficiency. The unthrottled engine also yields lower NO/sub x/ emissions, which were found to be a strong function of fuel-air equivalence ratio. (LCL)

24358 **Polyolefin/acylated poly(alkyleneamine) two component fuel additive.** Scheule, H.J.; Starn, R.E. Jr. (to E. I. Du Pont de Nemours & Co.). US Patent 4,173,456. 6 Nov 1979. Filed date 6 Feb 1978. 14p.

Two component fuel additive compositions comprising a hydrocarbon-soluble, acylated, poly(alkyleneamine) and from 1 to 10 parts per part of said poly(alkyleneamine) of a normally liquid, hydrocarbon-soluble polymer of a C_2 to C_6 monoolefin or diolefin; also a concentrated hydrocarbon solution of said additive and a fuel composition containing an amount of said additive effective to provide carburetor detergency in spark-ignition engines.

MATERIALS

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 23417

24359 **Ion beam technique for the measurement of deuterium diffusion coefficients.** Lewis, M.B.; Farrell, K. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Appl. Phys. Lett.*; **36**: No. 10, 819-821(15 May 1980).

This letter describes how a combination of the techniques of nuclear microanalysis and cathodic hydrogenation has been used to determine the diffusion coefficient of dueterium in austenitic stainless steel at room temperature. Samples charged in deuterated acid solutions to levels of about 20 at. % deuterium were quickly transferred to a scattering chamber where a depth profile of the near-surface deuterium was measured. For charging times much longer than the transfer plus anlyzing time, the deuterium profile could be described by an error function at the specimen surface. A diffusion coefficient was determined by a chi-squared test fitting procedure and shown to be consistent with values reported for other methods measured at higher temperatures.

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 24161, 24386, 24508

24360 **Delta ferrite-containing austenitic stainless steel resistant to the formation of undesirable phases upon aging.** Leitnaker, J.M. US Patent Application 052,180. [nd]. 20p.

Austenitic stainless steel alloys containing delta ferrite, such as are used as weld deposits, are protected against the transformation of delta ferrite to sigma phase during aging by the presence of carbon plus nitrogen in a weight percent 0.015 to 0.030 times the volume percent ferrite present in the alloy. The formation of chi phase upon aging is controlled by controlling the Mo content.

24361 **Method of winning aluminum metal from aluminous ore.** Loutfy, R.O.; Keller, R.; Yao, N.P. US Patent Application 048,332. [nd]. 15p.

Aluminous ore such as bauxite containing alumina is blended with coke or other suitable form of carbon and reacted with sulfur gas at an elevated temperature. For handling, the ore and coke can be extruded into conveniently sized pellets. The reaction with sulfur

gas produces molten aluminum sulfide which is separated from residual solid reactants and impurities. The aluminum sulfide is further increased in temperature to cause its decomposition or sublimation, yielding aluminum subsulfide liquid (A1S) and sulfur gas that is recycled. The aluminum monosulfide is then cooled to below its disproportionation temperature to again form molten aluminum sulfide and aluminum metal. A liquid-liquid or liquid-solid separation, depending on the separation temperature, provides product aluminum and aluminum sulfide for recycle to the disproportionation step.

24362 Method of manufacturing a niobium-aluminum-germanium superconductive material. Wang, J.L.F.; Pickus, M.R.; Douglas, K.E. US Patent Application 008,622. [nd]. 10p.

A method for manufacturing flexible Nb_3 (Al,Ge) multifilamentary superconductive material in which a sintered porous Nb compact is infiltrated with an Al-Ge alloy. It is deformed and heat treated in a series of steps at successively higher temperatures preferably below 1000°C during the heat treatment, cladding material such as copper can be applied to facilitate a deformation step preceding the heat treatment and can remain in place through the heat treatment to serve as a temperature stabilizer for the superconductive material produced. These lower heat treatment temperatures favor formation of filaments with reduced grain size and with more grain boundaries which in turn increase the current-carrying capacity of the superconductive material.

24363 Fe-based long range ordered alloys. Liu, C.T. US Patent Application 047,444. [nd]. 12p.

Malleable long range ordered alloys with high critical ordering temperatures exist in the $V(Co,Fe)_3$ and $V(Co,Fe,Ni)_3$ system. The composition comprising by weight 22 to 23% V, 35 to 50% Fe, 0 to 22% Co and 19 to 40% Ni with an electron density no greater than 8.00. Excellent high temperature properties occur in alloys having compositions comprising by weight 22 to 23% V, 35 to 45% Fe, 0 to 10% Co, 25 to 35% Ni; 22 to 23% V, 28 to 33% Ni and the remainder Fe; and 22 to 23% V, 19 to 22% Co and the remainder Fe. The alloys are fabricable by casting, deforming and annealing for sufficient time to provide ordered structure.

24364 Decomposition of silane on tungsten or other materials. Wiesmann, H.J. US Patent Application 030,974. [nd]. 20p.

This invention relates to hydrogenated amorphous silicon produced by thermally decomposing silane (SiH_4) or other gases comprising H and Si, from a W or foil heated to a temperature of about 1400 to 1600°C, in a vacuum of about 10^{-6} to 10^{-4} torr. A gaseous mixture is formed of atomic hydrogen and atomic silicon. The gaseous mixture is deposited onto a substrate independent of and outside the source of thermal decomposition. Hydrogenated amorphous silicon is formed. The presence of an ammonia atmosphere in the vacuum chamber enhances the photoconductivity of the hydrogenated amorphous silicon film.

24365 Process for treating weldments. Malik, R.K. US Patent Application 033,088. [nd]. 17p.

The tensile ducttility and impact strength of weldments of nickel-based and stainless steel alloys are improved to that of the unaffected base metal by subjecting the weldments to an elevated temperature at an isostatic pressure for a period of time sufficient to render the material in the weld more homogeneous.

24366 Pre-treatment for molybdenum or molybdenum-rich alloy articles to be plated. Wright, R.R. US Patent Application 022,897. [nd]. 8p.

A method is described for etching a molybdenum or molybdenum-rich alloy surface to promote the formation of an adherent bond with a subsequently deposited metallic plating. In a typical application, the method is used as a pre-treatment for surfaces to be electrolessly plated with nickel. The pre-treatment comprises exposing the crystal boundaries of the surface by anodizing the surface in acidic solution to form a continuous film of gray molybdenum oxide and removing the film.

24367 Thermal decomposition of silane to form hydrogenated amorphous Si. Strongin, M.; Ghosh, A.K.; Wiesmann, H.J.; Rock, E.B.; Lutz, H.A. III. US Patent Application 052,278. [nd]. 15p.

Hydrogenated amorphous silicon is produced by thermally decomposing silane (SiH_4) or other gases comprising H and Si, at elevated temperatures of about 1700 to 2300°C, in a vacuum of about 10^{-8} to 10^{-4} torr. A gaseous mixture is formed of atomic hydrogen and atomic silicon. The gaseous mixture is deposited onto a substrate to form hydrogenated amorphous silicon.

24368 (K/CSD/INF—79/27) Numerical methods for the analysis of laser annealing of doped semiconductor wafers. Kirkpatrick, J.R.; Giles, G.E. Jr.; Wood, R.F. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 1980. Contract W-7405-ENG-26. 11p. (CONF-800712—1). NTIS, PC A02/MF A01.

From 15. AIAA thermophysics conference; Snowmass, CO, USA (14 Jul 1980).

Certain classes of semiconductor devices can be manufactured by ion implantation of the dopant. Crystal damage resulting from the ion implantation can be annealed by melting the surface layer using a short, high-intensity laser pulse. The dopant atoms are redistributed during melting and resolidification. Analysis of this process requires studying two separate problems, each with its own difficulties. Heat transfer calculations with spatially and temporally varying internal heat sources and change of phase give the depth of melting, duration of the melted layer, and resolidification velocity. Dopant transport calculations give the diffusion of the dopant in the liquid and include segregation at the phase boundary.

24369 (LBL—10259) Weldability of thermally grain-refined Fe-12Ni-0.25Ti for cryogenic structural applications. Williams, D.E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1980. Contract W-7405-ENG-48. 43p. NTIS, PC A03/MF A01.

The weldability of a research alloy designed for structural use in liquid helium temperature, cryogenic environments was investigated. Plates of iron-12 weight percent nickel-0.25 weight percent titanium were grain refined by the four-step, grain refining thermal treatment developed for this alloy and welded with Inconel Number 92 weld wire using the Gas Metal Arc (GMA) welding process with argon-15% helium gas shielding. Both a single pass and a double-sided, 2 pass electron beam (EB) weld were also made without filler metal addition. Weldments were radiographed and sectioned and the charpy V-notch specimens removed were tested at liquid nitrogen and helium temperatures.

24370 Self-disintegrating raney metal alloys. Oden, L.L.; Russell, J.H. (to Dept. of Energy). US Patent 4,175,954. 27 Nov 1979. Filed date 24 Jul 1978. 6p.

PAT-APPL-927,235.

A method is described for preparing a Raney metal alloy which is capable of self-disintegrating when contacted with water vapor. The self-disintegrating property is imparted to the alloy by incorporating into the alloy from 0.4 to 0.8 weight percent carbon. The alloy is useful in forming powder which can be converted to a Raney metal catalyst with increased surface area and catalytic activity.

24371 (UCRL-Trans—11542) Viscosity of metals in explosive welding. Zakharenko, I.D.; Mali, V.I. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1979. Translated from pp 575-578 of Gorenie i vzryv, materialy tret'ego vsesoyuznogo simpoziuma go goreniyu i vzryvu, 5-10 July 1971, Nauka, Moscow, 1972. 8p. NTIS, PC A02/MF A01.

A mathematical analysis of explosive welding is given for metal plates. (FS)

24372 Alloys for a liquid metal fast breeder reactor. Rowcliffe, A.F.; Bleiberg, M.L.; Diamond, S.; Bajaj, R. (to Dept. of Energy). US Patent 4,172,742. 30 Oct 1979. Filed date 6 Jan 1978. 12p.

PAT-APPL-867,656.

An gamma-prime was precipitation-hardened iron-chromium-nickel alloy was designed with emphasis on minimum nickel and chromium contents to reduce the swelling tendencies of these alloys when used in liquid metal fast breeder reactors. The precipitation-hardening components have been designed for phase stability and such residual elements as silicon and boron, also have been selected to minimize swelling. Using the properties of these alloys in one design would result in an increased breeding ratio over 20% cold worked stainless steel, a reference material, of 1.239 to 1.310 and a reduced doubling time from 15.8 to 11.4 years. The gross stoichiometry of the alloying composition comprises from about 0.04% to about 0.06% carbon, from about 0.05% to about 1.0% silicon, up to about 0.1% zirconium, up to about 0.5% vanadium, from about 24% to about 31% nickel, from 8% to about 11% chromium, from about 1.7% to about 3.5% titanium, from about 1.0% to about 1.8% aluminum, from about 0.9% to about 3.7% molybdenum, from about 0.04% to about 0.8% boron, and the balance iron with incidental impurities.

24373 Microstructure and magnetic properties of Fe-Cr-Co alloys. Okada, M. (Univ. of California, Berkeley); Thomas, G.; Homma, M.; Kaneko, H. *IEEE Trans. Magn.;* **MAG-14**: No. 4, 245-252(Jul 1978).

The microstructures of an Fe-31 wt % Cr-23 wt % Co ductile permanent magnet alloy after isothermal aging, thermomagnetic treatment, and step aging have been characterized by transmission electron microscopy and by measurement of the Curie temperature. Isothermal aging itself produces the undesirable microstructure. Aging at 600°C develops the magnetic chromium-rich phase. Aging at 600°C produces a nonmagnetic chromium-rich phase dispersed within the iron-rich phase. The effect of thermomagnetic treatment on the microstructure of the alloy is discussed in comparison with that of Alnico alloys. Step aging produces the desirable microstructue, viz., the elongated ferromagnetic phase imbedded in the paramagnetic phase.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 24360, 24363, 24373

24374 (CONF-791112—62) **Structural defects in laser- and electron-beam annealed silicon.** Narayan, J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 14p. NTIS, PC A02/MF A01.

From Symposium on the scientific basis for nuclear waste management; Boston, MA, USA (26 Nov 1979).

Laser and electron beam pulses provide almost an ideal source of heat by which thin layers of semiconductors can be rapidly melted and solidified with heating and cooling rates exceeding 10^{10}°C/sec. Microstructural modifications obtained as a function of laser parameters are examined and it is shown that both laser and electron beam pulses can be used to remove displacement damage, dislocations, dislocation loops and precipitates. Annealing of defects underneath the oxide layers in silicon is possible within a narrow energy window. The formation of cellular structure provides a rather clear evidence of melting which leads to segregation and supercooling, and subsequent cell formation.

24375 (ORNL/TM—7247) **Effective diffusion coefficients of point defects in impure materials.** Mansur, L.K. (Oak Ridge National Lab., TN (USA)). Mar 1980. Contract W-7405-ENG-26. 27p. Dep. NTIS, PC A03/MF A01.

Effective diffusion coefficients of vacancies and interstitials in a material containing impurities are derived in terms of impurity and point defect concentrations and reaction parameters. Irradiation and thermal conditions are considered. Several expressions presented earlier are reviewed. These are found to be limiting or approximate forms to a more general result. The regimes of importance of the point defect processes of thermal dissociation, trapping, recombination with bound point defects of the opposite type, and impurity-associated transport to sinks are evaluated in terms of the structure of the effective diffusion coefficients.

24376 Comparative analysis of the cellular and Johnson-Mehl microstructures through computer simulation. Mahin, K.W.; Hanson, K.; Morris, J.W. Jr. (Univ. of California, Berkeley). *Acta Metall.;* **28**: No. 4, 443-453(Apr 1980).

The geometric properties of polygranular microstructures of the Johnson-Mehl cellular types have been studied through computer simulation. These prototypic microstructures arise naturally from the classical model of a phase transformation in a one-component solid through growth from a random distribution of nucleation sites. The Johnson-Mehl microstructure results in the kinetic limit of a constant nucleation rate over an essentially constant density of available nucleation sites; the cellular microstructure is produced in the kinetic limit of simultaneous activation of the available nucleation sites. Members of each of these microstructure types are similar to one another in all aspects of their geometrical statistics; they differ only through a homogeneous expansion or contraction. Their geometric features have been characterized through a combination of analytic and computer simulation studies. Comparison with available experimental results shows that the Johnson-Mehl microstructure compares well with such metallurgically diverse experimental structures as the recrystallization structure of silicon iron and the intermediate structures established during the ordering of lithium ferrite. These correspondences suggest that the idealized microstructures studied here may be physically relevant as well as being pedagogically useful.

24377 High-pressure phase in americium metal. Roof, R.B. (Los Alamos Scientific Lab., NM); Haire, R.G.; Schiferl, D.; Schwalbe, L.A.; Kmetko, E.A.; Smith, J.L. *Science;* **207**: 1353-1355(Mar 1980).

X-ray diffraction studies at high pressure (above 150 kilobars) show that americium metal undergoes a phase change from a high-symmetry, face-centered cubic structure to an orthorhombic α-uranium structure. This transition results from the onset of f-electron bonding as the lattice is compressed.

24378 Structure-property relations and the design of Fe-4Cr-C base structural steels for high strength and toughness. Narasimha Rao, B.V.; Thomas, G. (Univ. of California, Berkeley). *Metall. Trans., A;* **11**: No. 3, 441-457(Mar 1980).

From Symposium on precipitation processes in structural steels; Denver, CO, USA (27 Feb 1978).

Some design guidelines for improving strength-toughness combinations in medium carbon structural steels are critically reviewed. From this, quaternary alloy development based on Fe/Cr/C steels with Mn or Ni additions for improved properties is described. Transmission electron microscopy and X-ray analysis reveal increasing amounts of retained austenite in these alloys with Mn content up to 2 wt % and Ni additions at 5 wt % after quenching from 1100°C. A corresponding improvement in toughness properties is also found. Grain refining results in a further increase in the amount of retained austenite. In addition, the excellent combinations of strength and toughness in these quaternary alloys are attributed to the production of dislocated lath martensite from a homogeneous austenite phase free from undissolved alloy carbides. The question of thermal instability of retained austenite following tempering is considered in detail and it is shown that the decomposition of retained austenite is closely related to the ease of nucleation and growth of cementite. Thus, graphitizing alloys elements such as Ni are beneficial in postponing the decomposition of retained austenite.

24379 Structure of the clean Re(1010) surface. Davis, H.L.; Zehner, D.M. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *J. Vac. Sci. Technol.;* **17**: No. 1, 190-193(Jan 1980).

Existing LEED data from the clean Re(1010) surface have been analyzed by comparing with the results of fully dynamical calculations for numerous models. The analysis indicates that this surface has the second layer atoms located directly below the centers of the geometric rectangles of the first layer. This geometry is one of the two possible terminations of the truncated bulk crystal. Further, the analysis indicates that the interlayer spacing between the 1st and 2nd atomic layers is contracted by about 17% from its bulk value, while the spacing beteeen the 2nd and 3rd layers may be slightly expanded. Since the data employed in the analysis consisted of only two diffracted beams, the above conclusions should be considered as tentative and accepted with reasonable caution. However, this is the first reported LEED analysis for the (1010) surface of an hcp metal. So it is of interest to determine whether our conclusions will be verified for Re and/or similar results found for other hcp metals.

24380 Quantitative characterization of high strength aluminum foils vapor deposited on curved surfaces. Springer, R.W.; Barthell, B.L.; Rohr, D. (Los Alamos Scientific Laboratory, University of California, P.O. Box 1663, Los Alamos, New Mexico 87545). W-7405-ENG-36. *J. Vac. Sci. Technol.;* **17**: No. 1, 437-440(Jan 1980).

The pulsed gas process (PGP) has been used to produce Al/Al/sub x/O/sub y/

24381 Bonding of Al and Ga to GaAs(110). Skeath, P.; Lindau, I.; Su, C.Y.; Chye, P.W.; Spicer, W.E. (Stanford Electronics Laboratories, Stanford University, Stanford, California 94305). *J. Vac. Sci. Technol.;* **17**: No. 1, 514-519(Jan 1980).

The interfacial electronic states associated with Al and Ga overlayers on cleaved GaAs (110) surfaces are studied by ultraviolet photoemission spectroscopy (UPS) and low energy electron diffraction (LEED). Deposition of Al or Ga can produce valence-band spectra nearly devoid of new structure. Sb produces quite significant changes in the surface valence band and is shown as a contrasting example. Pseudopotential calculations from the literature for Al- and Ga-ordered overlayers are found to be in somewhat better agreement with the data than the corresponding tight-binding calculations, particularly in the adatom states which lie above the GaAs valence-band maximum (VBM), although neither calculation gives a good description of the observed overlayer states. It is shown that Al and Ga most likely form two-dimensional clusters or rafts on the surface at submonolayer coverage which are not in registry with the GaAs surface lattice. A comparison is made with results by other workers for Al, Ga, and In on GaAs and Si.

24382 Equilibrium transition temperature of thermoelastic martensitic transformations. Mohamed, H.A. (Univ. of California, Berkeley). *J. Mater. Sci.;* **13**: 1364-1366(1978).

In a study of the thermodynamics of thermoelastic martensite transformations, the conditions that determine the A/sub f/ temperature relative to T_0 were examined and a simple method of bracketing T_0 is proposed. A/sub f/ is the temperature at which the reversion of martensite (M) to the high temperature phase (HTP) is completed during heating. T_0 is the temperature at which the chemical free energy difference per unit volume Δg/sub ch/ (M → HTP, HTP → M) =0. Δg/sub ch/ is the chemical free energy difference per unit volume. (FS)

24383 Point-obstacle representation of the dislocation-obstacle interaction. Morris, J.W. Jr.; Syn, C.K. (Univ. of California, Berkeley). *J. Appl. Phys.;* **45**: No. 2, 961-963(Feb 1974).

A general method is given for constructing the point-obstacle representation of the interaction between a dislocation and a physical obstacle. The equations of equilibrium are derived. The elastic interaction of a simple dislocation with a row of equispaced solute atoms which behave as repulsive barriers is treated as an illustration.

24384 Indexing of diffracting planes using the Kikuchi pattern. Wu, W.; Chen, L.J.; Washburn, J.; Thomas, G. (Univ. of California, Berkeley). *J. Appl. Phys.;* **45**: No. 2, 563-566(Feb 1974).

Two types of ambiguity concerning indexing of electron diffraction patterns have been cleared up by making use of the Kikuchi lines. A convenient unambiguous method of uniquely indexing patterns is suggested assuming the beam is always along the viewing direction no matter how the picture is printed. It is shown that there are two completely equivalent ways of indexing the Kikuchi pattern, e.g., [111] or [anti 1 anti 1 anti 1]. The method is

also useful in interpreting dark-field pictures when top-bottom contrast is concerned.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 23419, 24049, 24072, 24369, 24370, 24372, 24374, 24378, 25093

24385 (ANL-CT—79-19) **Use of endochronic plasticity for multi-dimensional small and large strain problems.** Hsieh, B.J. (Argonne National Lab., IL (USA)). Apr 1980. Contract W-31-109-ENG-38. 103p. NTIS, PC A06/MF A01.

The endochronic plasticity theory was proposed in its general form by K.C. Valanis. An intrinsic time measure, which is a property of the material, is used in the theory. the explicit forms of the constitutive equation resemble closely those of the classical theory of linear viscoelasticity. Excellent agreement between the predicted and experimental results is obtained for some metallic and non-metallic materials for one dimensional cases. No reference on the use of endochronic plasticity consistent with the general theory proposed by Valanis is available in the open literature. In this report, the explicit constitutive equations are derived that are consistent with the general theory for one-dimensional (simple tension or compression), two-dimensional plane strain or stress and three-dimensional axisymmetric problems.

24386 (DOE/ER/10430—1) **Hydrogen absorption in metals: a field ion microscopy study. Progress report, June 1, 1979-May 31, 1980.** Sakurai, T.; Pickering, H.W. (Pennsylvania State Univ., University Park (USA)). Feb 1980. Contract AC02-79ER10430. 9p. NTIS, PC A02/MF A01.

Progress is summarized in: sample preparation, computer interfacing for automated data acquisition and computer simulation of ion optics of atom-probes, in addition to the actual chemical compositional anaysis of the Fe-Ti alloy samples and observations on hydrogen-induced microcracking. It is found that Ti segregates at the surface and grain boundaries when heated to and above 800°C. Some of the Ti atoms form clusters with carbon, nitrogen and oxygen as a nucleus. The formation and propagation of a microcrack involving hydrogen was documented for the first time on a truly atomic scale.

24387 Constitutive equation for porous materials with strength. Swegle, J.W. (Sandia Laboratories, Albuquerque, New Mexico 87185). DE-AC04-76-DP00789. *J. Appl. Phys.;* **51**: No. 5, 2574-2580(May 1980).

A constitutive equation for porous materials capable of supporting deviatoric stresses is described. The model incorporates the deviatoric stresses in a physically consistent manner so that the porosity is a function of the complete stress tensor and such phenomena as shear-enhanced pore compaction may be represented. The constitutive equation is based on the physical concept of a closed yield surface in stress space which varies as the material porosity changes. An example of the application of the model to 22% porous 2024 aluminum is given.

24388 Cyclic creep of Type 304 stainless steel during unbalanced tension-compression loading at elevated temperature. Turner, A.P.L.; Martin, T.J. (Argonne National Lab., IL). *Metall. Trans., A;* **11**: No. 3, 475-481(Mar 1980).

Samples of Type 304 stainless steel were subjected to cyclic stresses with a positive mean stress at 300 and 560°C. Very rapid net elongation was observed whenever the stress limits were such as to produce a plastic strain amplitude of the same order of magnitude as the elastic strain at the peak stress. The maximum mean strain-rate, or cyclic creep rate, for a given peak tensile stress was achieved when the mean stress was just slightly above zero. Increasing the mean stress caused the mean strain rate to decrease. The sensitive dependence of the mean strain-rate on the plastic strain amplitude and inverse dependence on the mean stress indicates that remobilization of dislocations by the reverse strain is an important mechanism for cyclic-creep acceleration. Although rapid cyclic creep was observed at both temperatures, a measurable mean strain rate was found for a much narrower range of stress conditions at 560 than at 300°C. The strain accumulated during cyclic creep did not produce any strain hardening, but did influence the shape of the stress-strain curve in a subsequent tensile test.

24389 Creep-rupture in powder metallurgical nickel-base superalloys at intermediate temperatures. Law, C.C.; Blackburn, M.J. (Pratt and Whitney Aircraft, East Hartford, CT). *Metall. Trans., A;* **11**: No. 3, 495-507(Mar 1980).

To gain insight into the factors which control the creep-rupture properties of powder metallurgical nickel-base superalloys at intermediate temperatures (650 to 775°C), a comparative study was conducted on the alloys AF115, modified MAR-M432 (B6) and modified IN100 (MERL76). Creep-rupture properties in these alloys were characterized in terms of the stress and temperature dependence of the secondary creep rate, ϵ/sub S/, and rupture time, t/sub R/. Within the limited stress ranges used, the stress dependence of both ϵ/sub S/ and t/sub R/ at 704°C can be represented by power laws ϵ/sub S/ = C σ/sup n/ and t/sub R/ = M σ/sup -p/; where C, M, n, and p are constants. The stress exponents n and p are approximately equal for both AF115 and B6 with values of 16 and 7, respectively. In the case of MERL76, n and p are different, with values of 15 and 5, respectively. The apparent activation energies, Q, are 700, 370, and 520 K J mol^{-1} for AF115, B6, and MERL76, respectively. For these alloys, long creep-rupture lives are associated with large values of n and Q. The significant differences in n and Q values between AF115 and B6 were related to creep recovery processes for which the lattice misfit between the gamma and the gamma prime was identified to be an important parameter. However, the unequal n and p values in MERL76 compared with those in AF115 and B6, were traced to differences in fracture mode. Failures in AF115 and B6 were initiated at carbide particles at grain boundaries. In contrast, fracture in MERL76 was initiated at grain boundary triple junctions. The rupture lives of AF115 and B6 can be modeled reasonably well by the growth of cavities during secondary creep and propagation of a surface-nucleated crack during the tertiary creep.

24390 Hydrogen attack of HSLA steels. Sundararajan, G.; Shewmon, P.G. (Ohio State Univ., Columbus). *Metall. Trans., A;* **11**: No. 3, 509-516(Mar 1980).

Three high strength low alloy steels with low carbon contents and varying alloy contents were exposed to 21 MPa (300 psi) hydrogen pressure in the temperature range 350 to 510°C. The resulting sample expansion rate was measured using a highly sensitive capacitance dilatometer. In all three HSLA steels, the early expansion rate was found to be independent of exposure time, but a function of exposure temperature and pressure. The temperature dependence of the sample expansion rate was similar for all three HSLA and the reference carbon steels, and corresponded roughly to an activation energy (Q) of 190 K J/mole. The later accelerating expansion rate fitted a Q of 160 K J/mole. Though the sample expansion rates exhibited the same temperature dependence, they varied by as much as two orders of magnitude among the three HSLA and the carbon steels. This marked variation in rate was proportional to the estimated carbon activity in each steel. Comparison between the Nelson curves published by the American Petroleum Institute (API) for 1/2% Mo steel and the experimental curves constructed for HSLA steels indicated that these steels should provide comparable or better resistance to hydrogen attack than the 1/2% Mo steel.

24391 Dispersion of life of bonded MoS2 solid lubricant coatings. Radcliffe, S.J.; Parry, A.A. (Brookhaven National Lab., Upton, NY). *Wear;* **56**: No. 1, 203-212(Sep 1979).

Wear tests of 70 specimens with similarly loaded MoS2 coatings were analyzed. The coating life (in cycles) was in general proportional to the thickness and inversely proportional to the load and amplitude, but there was considerable scatter. The results could be expressed in terms of a specific wear rate fitting a mixed Weibull distribution.

24392 Use of acoustic emission for assessing the integrity of a nuclear reactor pressure vessel. Ying, S.P. *NDT Int.;* **12**: No. 4, 175-179(Aug 1979).

Acoustic emission experiments were conducted during hydrostatic tests and thermal shock tests on flawed pressure vessels. Four 152 mm thick vessels of A-533B and A-508-2 steels with flaws in the vessel walls and in the nozzle corners were tested at various temperatures. Acoustic emissions from cracks were characterized by their temperatures and by the stress field present. Two thermal shock tests, classified as a crack propagation and arrest experiment, were performed. The detected sound pressure levels of acoustic emission resulting from crack propagation during thermal shock were relatively large in comparison with the emissions related to plastic deformation and the approach to crack initiation.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 24364, 24366, 24368, 24373, 24578, 24834, 24959, 24969

24393 (CONF-791112—65) **Infrared reflectiity and transmissivity of boron implanted, laser annealed silicon.** Engstrom, H. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 6p. NTIS, PC A02/MF A01.

From Symposium on the scientific basis for nuclear waste management; Boston, MA, USA (26 Nov 1979).

The mid-infrared reflectance and transmittance of boron implanted, laser annealed silicon was measured. A Drude model of free holes was used to obtain the dielectric constant of the implanted layer. A least squares adjustment of (1) the ratio of boron concentra-

tion to effective hole mass; and (2) the relaxation time gave a fairly good fit to the data and permitted determination of these parameters.

24394 (CONF-791132—5) **HVEM in situ hydriding of hydrogen storage materials.** Kenik, E.A.; Mullins, J.; Spooner, S.; Livesay, B.R. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 4p. NTIS, PC A02/MF A01.

From 2. JIM international symposium on hydrogen in metals; Minakami Spa, Japan (26 Nov 1979).

The microstructural changes induced during hydriding have been investigated by high-voltage electron microscopy and in situ hydriding studies. Hydriding generates high dislocation densities, which has implications for the mechanism involved in the hydride transformation and possible effects of prior hydrogen exposures on subsequent hydriding behavior. In situ hydriding of $LaCo_5$ and $LaNi_2Co_3$ has been demonstrated. There appears to be an activation barrier to hydriding at low hydrogen pressures. This barrier may be reduced or eliminated by heating to $\sim$ 200°C under a low partial pressure of hydrogen. Internal stresses generated by hydriding result in cracking and ultimately the fracture of thin foil specimens. The hydriding process either involves some dislocation mechanism such as slip or twinning or generates dislocations by the internal stresses set up during hydriding.

24395 (LA-UR—80-1252) **Thermodynamics of the tantalum-carbon-chlorine-hydrogen system applied to the CVD of carbide/carbon composite materials.** Behrens, R.G.; Newkirk, L.R.; Wallace, T.C. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 33p. (CONF-800460—3). NTIS, PC A03/MF A01.

From 82. annual American Ceramic Society meeting; Chicago, IL, USA (27 Apr 1980).

Complex equilibrium thermodynamic calculations using the computer code SOLGASMIX-PV were performed for the Ta-Cl-H and Ta-C-Cl-H systems in order to evaluate the chemistry associated with the chemical vapor deposition of Ta, Ta_2C, and TaC on graphite yarn and woven structures. Results of the thermodynamic calculations were compared with coated materials prepared by hydrogen reduction of $TaCl_5$(g) and C_3H_6(g) between 1025 and 1223°K using a variety of reaction gas compositions.

24396 Anomalous behavior of the Grueneisen parameter in cerium near the high-pressure phase transition. Ramakrishnan, J.; Kennedy, G.C. (Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024). DE-AT03-76ER70171. *J. Appl. Phys.;* **51**: No. 5, 2586-2588(May 1980).

Measurements have been made of the value (partialT/partialP)/sub s/ as a function of pressure up to 32 kbar, at room temperature (296.7 °K), for cerium through its electronic transition at 7.5 kbar. The thermodynamical Grueneisen parameter is calculated using the thermodynamic relation γ/sub th/=(B-italic/sub s//T)(partialT/partialP)/sub s/, where B/sub s/ is the adiabatic bulk modulus. An anomalous increase of γ/sub th/ in the low-pressure phase and a rapid decrease after the transition are obtained for cerium.

24397 Prediction of the stress state in Nb_3Sn superconducting composites. Easton, D.S.; Kroeger, D.M.; Specking, W.; Koch, C.C. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *J. Appl. Phys.;* **51**: No. 5, 2748-2757(May 1980).

The critical current I/sub c/ as a function of applied tensile strain depends upon the residual stress state that exists in Nb_3Sn bronze-process composite conductors after cooling from the reaction temperature to 4.2 K. This paper presents a simple analytical method to predict the residual stress state and the stress-strain curves of Nb_3Sn composites at 4.2 K. The method requires only a prior knowledge of the volume fraction of the composite components and the percentage of Nb converted to Nb_3Sn. Experimental results and analytically derived values are compared and good agreement is generally found.

24398 Optical properties of liquid tin between 0.62 and 3.7 eV. Petrakian, J.P.; Cathers, A.R.; Parks, J.E.; MacRae, R.A.; Callcott, i.A.; Arakawa, E.T. (Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3043-3046(15 Apr 1980).

The optical constants of liquid tin at 261 °C have been deduced from ellipsometric measurements for photon energies between 0.62 and 3.7 eV. Liquid tin behaves like a nearly-free-electron metal over the measured range. The Drude parameters were derived from the real part of the dielectric constant, giving tau=4.90 x 10^{-16} sec for the relaxation time and m*/m=0.98 for the ratio of the effective mass to free-electron mass. Comparison is made with previous results for liquid tin and also with data for solid tin.

24399 Photoemission studies of hydrogen chemisorption on Nb. Smith, R.J. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). EY-76-C-02-0016. *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3131-3136(15 Apr 1980).

Photoemission results are presented for recrystallized Nb foils and for chemisorbed hydrogen on Nb. A split-off bonding orbital due to adsorbed H is observed below the d bands. The temperature dependence of this photoemission feature above 300 K and the kinetics of its growth and saturation suggest that H may exist in two quite different states near the surface of Nb. The interpretation of these results as they relate to recent measurements of hydrogen uptake in Nb is also discussed.

24400 Kinetics of two-state chemisorption: Hydrogen on niobium. Johnson, R.A.; Dienes, G.J. (University of Virginia, Charlottesville, Virginia 22901). *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3137-3139(15 Apr 1980).

In the two-state model of chemisorption, it is assumed that there is a given density of chemisorption sites on the surface, each of which can exist in either of two states. The general rate equations were formulated and solved analytically under the assumption that the above two states are in local equilibrium. The kinetic equations describe accurately the photoemission data of Smith of hydrogen chemisorption on pure niobium. The analysis indicates that the two sites are tightly bound with a rather shallow ($\sim$ 5 kcal/mole H) barrier between them.

24401 Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/. Rosei, R.; Colavita, E.; Franciosi, A.; Weaver, J.H.; Peterson, D.T. (Ames Laboratory, USDOE, Ames, Iowa 50010). *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3152-3157(15 Apr 1980).

Thermoreflectance studies of bulk samples of V, Nb, Ta, and α-phase TaH/sub x/ are reported and the results interpreted in terms of recent band calculations. The first interband transition is identified as a transition involving the Σ band at E/sub F/. An M_3 critical-point transition is attributed to states at N. Significant changes induced by interstitial hydrogen in solid solution α-TaH/sub x/ are observed and interpreted as due to hybridization and lowering of the N/sup prime/$_1$ eigenenergy.

24402 k dependence of the conduction-electron—local-moment exchange interaction in the atomic and covalent-mixing limits. Lowndes, D.H.; Hendel, C.L.; Hendel, R.; Crabtree, G.W. (University of Oregon, Eugene, Oregon 97403). *Phys. Rev. Lett.;* **44**: No. 15, 1012-1015(14 Apr 1980).

The k dependence of the conduction-electron—rare-earth-moment exchange interaction is directly measured for the first time and found to be opposite in sense for Gd and Yb impurities in Au. Atomic exchange dominates for Au(Gd), while a phase-shift analysis indicates that covalent mixing of conduction p waves accounts for the observed k dependence in Au(Yb).

24403 Influence of dislocation drag on twinning in zinc. Motowidlo, L.; Goldman, P.; Yalamanchi, B.; Galligan, J.M. (Department of Metallurgy and Institute of Materials Science, University of Connecticut, Storrs, Connecticut 06268). *Phys. Rev. Lett.;* **44**: No. 14, 934-936(7 Apr 1980).

This paper presents measurements of the influence of magnetic fields on the plastic deformation of zinc. In particular it is shown that both slip processes and twinning are affected by the presence or absence of magnetic fields. Furthermore, it is shown that the motion of dislocations is required for twinning and that twinning can be altered through a change in magnetic field which determines the dislocation velocity. These results are explained by treating the dislocations as underdamped oscillators.

24404 Effect of strain upon the scaling law for flux pinning in bronze process Nb_3Sn. Kroeger, D.M.; Easton, D.S.; DasGupta, A.; Koch, C.C.; Scarbrough, J.O. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *J. Appl. Phys.;* **51**: No. 4, 2184-2192(Apr 1980).

The semiempirical scaling law for flux pinning, F/sub p/=AB/sup n//sub c/2b/sup l/ (1-b)/sup m/ has been tested for bronze process Nb_3Sn conductors under uniaxial tension. The dependences of the bulk pinning force F/sub p/ on the upper critical field B/sub c/2 and the reduced field, b=B/B/sub c/2, were weakly affected by strain. However, the factor A, which depends on the number and strength of the pinning centers, and on the Ginzburg-Landau parameter κ decreased by more than a factor of 20 when the compressive prestrain on the Nb_3Sn was removed by application of external stress. The variations of T/sub c/ and B/sub c/2 with strain suggest that the change in κ is not sufficient to account for the change in A. Therefore, it is probable that strain induces microstructural changes which affect the number and/or strength of the pinning centers.

24405 Resistivity anomaly in thin Bi wires: Possibility of a one-dimensional quantum size effect. Gurvitch, M. (Brookhaven National Laboratory, Upton, New York). *J. Low Temp. Phys.;* **38**: No. 5, 777-791(1 Mar 1980).

Thin Bi single-crystal wires down to ~0.2 μm in diameter were prepared by pressing liquid Bi into fine Pyrex capillaries. Electron microphotographs were taken to determine the diameter of the wires. Anisotropic magnetoresistance together with Shubnikov—de Haas oscillations were observed at helium temperatures. An anomalous drop in resistivity rho(T) was found at T<50 K. Possible explanations are considered, including one based on the quantum size effect.

24406 Low energy electron diffraction (LEED) study of the adsorption of acetic acid and propanoic acid on Ag(111) and Pt(111). Firment, L.E.; Somorjai, G.A. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory and Department of Chemistry, University of California, Berkeley, California 94720). *J. Vac. Sci. Technol.;* **17**: No. 2, 574-577(Mar 1980).

The adsorption of acetic acid and of propanoic acid on Ag(111) and Pt(111) single crystal surfaces has been studied with LEED. Both acetic acid and propanoic acid formed two-dimensional structures in two different types of orientation on Ag(111) and propanoic acid apparently formed the same structure on graphite covered Pt(111). Neither acid formed ordered monolayers when adsorbed on clean Pt(111). The similar LEED data and physical properties of the acid molecules suggested similar structures for both acids consisting of closely packed arrays of hydrogen-bonded dimers.

24407 Sulfur and oxygen chemistry at free surfaces and grain boundaries of iron alloys. Thomas, M.T.; Baer, D.R.; Jones, R.H.; Bruemmer, S.M. (Pacific Northwest Laboratory, Richland, Washington 99352). EY-76-C-06-1830. *J. Vac. Sci. Technol.;* **17**: No. 1, 25-28(Jan 1980).

This paper reports a study of grain boundary and free surface segregation in iron alloys. Scanning Auger electron spectroscopy has been used to analyze the extent and spatial distribution of the segregants. It is found that there is a similarity between free surface and grain boundary segregation for vacuum-melted (vm) and zone-refined (zr) materials. S and O are the primary segregants to grain boundaries for vm samples, while N is the predominant segregant for zr material. When O and S are the primary segregated elements, a site competition between them is observed on both the free surface and at grain boundaries. On the free surface the site competition is dependent on grain orientation.

24408 1979 LEED analysis of Cu(100). Noonan, J.R.; Davis, H.L. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *J. Vac. Sci. Technol.;* **17**: No. 1, 194-197(Jan 1980).

The crystallography of the Cu(100) surface is reexamined by a LEED I—V profile analysis in order to investigate the effects of applying current experimental and computational techniques. The study produces a very small multi-beam reliability factor of 0.068, and it is concluded that the first interlayer spacing of Cu(100) is within 2% of the bulk value. The work also demonstrates that agreement between calculational and experimental I—V profiles can be significantly improved by the simple process of data averaging the experimental profiles which should be symmetrically equivalent.

24409 Enhanced photoexcitation from the surface of aluminum. Levinson, H.J.; Plummer, E.W.; Feibelman, P. (Department of Physics, Philadelphia, Pennsylvania 19104). DE-AC04-76-DP00789. *J. Vac. Sci. Technol.;* **17**: No. 1, 216-218(Jan 1980).

The enhancement of photoionization cross sections due to the spacially varying photon field at the surface of a metal has been observed by measuring the cross section for the surface state and Fermi level on Al(001) for photon energies between 9 and 23 eV. The data are in excellent agreement with the results of a self-consistent jellium calculation which takes into account the induced short wavelength longitudinal fields at the surface of the metal. These fields are much more effective than the transverse fields in providing the momentum necessary for photoexcitation and this mechanism dominates all others, including direct vertical transitions, in the energy range considered. The implications of this effect on photoemission studies of surface and bulk properties will be discussed.

24410 Properties and applications of ion-implanted alloys. Myers, S.M. (Sandia Laboratories, Albuquerque, New Mexico 87185). DE-AC04-76-DP00789. *J. Vac. Sci. Technol.;* **17**: No. 1, 310-314(Jan 1980).

Ion implantation is a controlled and versatile means for near-surface alloying of metals. Supersaturated solutions, meastable compounds, amorphous phases, and equilibrium alloys have been produced. Uses include the investigation of metastable phases, characterization of alloying reactions ocurring in conventional materials, and improvement of surface properties such as hardness, wear, and corrosion. A brief review is given of the physical processes occurring during ion implantation, the types of alloys which result, and representative applications.

24411 Characterization of black Ge selective absorbers. Swab, P.; Krishnaswamy, S.V.; Messier, R. (Pennsylvania State University, Materials Research Laboratory, University Park, Pennsylvania 16802). EM-78-C-04-5302. *J. Vac. Sci. Technol.;* **17**: No. 1, 362-365(Jan 1980).

We have prepared structurally anisotropic black Ge films by rf sputtering and postdeposition etching. By careful control of various sputtering condition such as rf power, gas pressure, deposition time, and other parameters such as nature and roughness of the substrate and etching time, we can alter the morphology of these films and optimize the selective absorbing properties. Postdeposition etching in 30% H_2O_2 has reduced the reflectance from approximately 45% to less than 1% in the best case. This etching behavior is also observed for films immersed in water for several weeks at room temperature. This is explained on the basis of oxidation through aligned voids. The etching behavior of various films and correlation between the resulting microstructure and optical properties is discussed. Further, the various microstructures are classified and understood using the structure zone models.

24412 Splitting of surface-plasmon emission spectra from potassium. Williams, M.W.; Ashley, J.C.; Kretschmann, E.; Callcott, T.A.; Chung, M.S.; Arakawa, E.T. (Oak Ridge National Lab., TN (USA)). *Phys. Lett., A;* **73**: No. 3, 231-233(17 Sep 1979).

Emission spectra from potassium films irradiated with 1.5 keV electrons have shown a splitting of the roughness-coupled surface-plasmon radiation into two peaks, as predicted by a recently developed theory.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 24015

24413 (MLM—2707(OP)) Nickel-iron alloy corrosion in a sealed pyrotechnic system. Tibbitts, E.E.; Salerno, R.F. (Mound Facility, Miamisburg, OH (USA)). 1980. Contract AC04-76DP00053. 22p. (CONF-800713—2). NTIS, PC A02/MF A01.

From 7. international pyrotechnics seminar; Vail, CO, USA (14 Jul 1980).

Actuators loaded with Ti/$KClO_4$ and aged for several days had chlorine-containing corrosion products on Alloy-52 electrode pins and Tophet-C bridgewire surfaces. An in-depth analysis of these materials indicated that moisture, organic contamination, and chlorine were the major causes of the corrosion. Definite evidence was uncovered that indicated a partial decomposition of the $KClO_4$ was the major source of the chlorine. In the presence of moisture, particles that settle on the metal surface cause the formation of galvanic or oxygen concentration cells that dissolve to produce electrolytes on the metal surface causing corrosion of the metal. Corrosion can be eliminated by reducing the humidity to below a critical level and vacuum drying the pyrotechnic so that no moisture is condensed on the metal. Since water is consumed in the reaction forming hydrated oxides or hydroxides, the extent of the reaction is limited by the amount of water in the sealed unit. Therefore, in unsealed, undesiccated assemblies, corrosion would probably continue with the rate varying with the ambient humidity. Since effective cleaning of the header and dry conditions are the key factors in eliminating the corrosion, honing, polishing, and passivating the metal surfaces provide added corrosion protection.

24414 (SAND—80-8215) Corrosion behavior of lean uranium-titanium alloys. Nagelberg, A.S.; Ottesen, D.K. (Sandia National Labs., Livermore, CA (USA)). Apr 1980. Contract EY-76-C-04-0789. 23p. NTIS, PC A02/MF A01.

Corrosion rates of a series of uranium-titanium alloys containing 0.8, 1.0, 1.5, and 2.0 weight % Ti have been carried out at 70°C in moist nitrogen at 95% relative humidity. Results are that it appears reasonable to consider relaxing the coating requirement currently placed on all uranium alloy components. The reduced total corrosion observed and minimal corrosion rate after an initial period make it reasonable to use unplated lean uranium-titanium alloys in situations where the presence of condensed water is minimal.

24415 AES and XPS study of plutonium oxidation. Larson, D.T. (Rockwell International, Rocky Flats Plant, Golden, Colorado 80401). *J. Vac. Sci. Technol.;* **17**: No. 1, 55-58(Jan 1980).

The initial oxidation of plutonium metal at 27°C has been studied using AES and XPS. Initially a "clean" plutonium surface was prepared by prolonged Ar^+ bombardment followed by 500°C anneal and Ar^+ bombardment cleaning cycles. Changes occurring in the plutonium Auger electron spectra in the energy range of 40—120 eV and the 4f/sub 5/2/, 4f/sub 7/2/ (core levels), and valence band XPS peaks were monitored during oxygen exposures of 10 to 1.8 x 10^6L. Examination of the 4f/sub 7/2/ level revealed two oxidation states which are attributed to a suboxide an PuO_2. The 4f/sub 7/2/ binding energies for the two oxidation states and plutonium metal are 426.1, 424.4, and 422.2 eV, respectively. It was observed that oxidation proceeded in two steps. In the first step there was a rapid

reaction of oxygen with the formation of a suboxide. In the second stage, the uptake of oxygen leveled off with conversion of the suboxide to PuO_2.

24416 Low-energy ion erosion studies of machine faceted stainless steel. Panitz, J.K.G.; Sharp, D.J. (Sandia Laboratories Albuquerque, New Mexico 87185). DE-AC04-76DP00789. *J. Vac. Sci. Technol.;* **17**: No. 1, 282-285(Jan 1980).

Type 304 annealed stainless-steel substrates with a variety of machine faceted surface finishes have been eroded by low-energy (250—1000 eV) hydrogen, and argon ion beams. The dimensions of the machine faceted features studied range from that of the annealed crystalline grain size (approximately 0.0125 cm) to 0.25-cm macrostructures. Relative erosion rates have been measured and analyzed as a separable function of angular dependent sputtered particle emission and particle recapture. It was found that the formation of a faceted topography on the surface of components exposed to low-energy, light-ion erosion can significantly reduce the effective ion erosion yield.

24417 Portable probe to measure sensitization of stainless steel. Park, J.Y. (to Dept. of Energy). US Patent 4,179,349. 18 Dec 1979. Filed date 26 Sep 1978. 4p.

PAT-APPL-945,924.

An electrochemical cell is described for making field measurements of metals such as stainless steel. It consists of a cylinder containing a reservoir of an electrolyte, a reference electrode, a capillary tube connecting the electrolyte to the surface of the metal to be measured and another electrode in electrical contact with the electrolyte. External connections from the reference electrode, the other electrode, and the sample to a measuring device provide means for maintaining the potential of the electrolyte while sweeping the potential difference between the electrolyte and the metal. Such a sweep enables the determination of a current-voltage characteristic that is a measure of sensitization in the metal.

24418 Literature review of palliatives for fretting fatigue. Gordelier, S.C.; Chivers, T.C. (Brookhaven National Lab., Upton, NY). *Wear;* **56**: No. 1, 177-190(Sep 1979).

Under cyclic stress conditions contacting components can suffer differential strain which may result in reduced fatigue life; such a phenomenon is termed fretting fatigue. This review shows that the palliative treatments advanced are superficially contradictory. However, examination shows that in reality the success of a pallitive is dependent upon the specific application. Assessing treatment against existing theory shows that the contradictions can be explained in a qualitative manner; the detailed behavior is strongly dependent upon the stress fields arising from both the contact and the relative moment. More work is required to quantify such effects and the way in which palliatives work. Potentially useful treatments are tabulated together with their probable route for providing alleviation, so that means of amelioration can be selected.

24419 Surface oxidation of nickel metal as studied by x-ray photoelectron spectroscopy. Allen, G.C.; Tucker, P.M.; Wild, R.K. (Brookhaven National Lab., Upton, NY). *Oxid. Met.;* **13**: No. 3, 223-236(Jun 1979).

X-ray photoelectron spectroscopy has been used to study the oxidation of polycrystalline nickel metal. The results indicate that the oxidation process takes place in three stages; associative adsorption of molecular oxygen, followed by the combination of oxygen atoms with surface nickel atoms and, ultimately, the formation of bulk oxide.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 24073, 24375, 25089, 25092, 25093

24420 (DOE/TIC—11202) **Swelling and phase instability in neutron irradiated compositional variants of alloy D9.** Sklad, P.S. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 30p. NTIS, PC A03/MF A01.

Several of the V-series alloys have been examined by transmission electron microscopy after irradiation in EBR-II to $\sim 7 \times 10^{22}$ n/cm^2 ($E > 0.1$ MeV) in pin B256. The specimens were irradiated in the solution-treated condition. Voids were observed in all specimens examined. However, the measured swelling varied significantly from a minimum of 0.6% in alloy V4 to a maximum of 10.1% in alloy V5, the alloy with the lowest concentration of Ti in solution. The swelling measured by TEM agrees fairly well with imersion density data and in general confirms the trends shown in this data.

24421 (HEDL-SA—1774-FP) **Relationship between swelling and the shear modulus of irradiated metal.** Bates, J.F. (Hanford Engineering Development Lab., Richland, WA (USA)). Feb 1979. Contract EY-76-C-14-2170. 11p. (CONF-790802—79). NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

In three alloy systems, AISI 316, the Ni-Al binary system, and the Fe-Cr-Ni ternary system, a relationship exists between the shear modulus of the unirradiated alloys and the resultant swelling observed. An alloying addition which reduces the shear modulus will subsequently reduce the irradiation-induced swelling in a solid solution hardened alloy system. The reduction in swelling is thought to be associated with the void nucleation phase of the swelling phenomenon. Thus, relative high temperature swelling behavior of the solid solution hardened alloys can be described with reasonable certainty from room temperature shear modulus measurement.

24422 (LA—8351-MS) **Post irradiation dose determination of 800 MeV proton irradiated aluminum from LAMPF experiment 407.** Sommer, W.F. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 14p. NTIS, PC A02/MF A01.

Recorded here are the results of post irradiation radiochemistry analysis of 800 MeV proton irradiated ultra high purity aluminum. Standard gamma-ray counting equipment, including a Ge Li detector, a multichannel analyzer, and associated electronics, was employed to count the ^{22}Na activity in the activated aluminum. Since activation is proportional to proton fluence, relative dose levels can be determined. Also, use of a selected production cross section for ^{22}Na in aluminum and a calculated damage energy cross section, both for 800 MeV proton bombardment, allows determination of a calculated value for the number of displacements per atom (dpa) that the material received during an irradiation experiment at the Clinton P. Anderson Meson Physics Facility (LAMPF). It is felt that simple and sufficiently accurate post irradiation dose determination can be made when either the subject material is ultra high purity aluminum or if this material is provided as a monitor with other subject materials, the simplicity being that the transmutation product, isotope ^{22}Na, is relatively abundant and has a long half-life.

24423 (ORNL/TM—7193) **Experimental observations of effects of inert gas on cavity formation during irradiation.** Farrell, K. (Oak Ridge National Lab., TN (USA)). Apr 1980. Contract W-7405-ENG-26. 41p. (CONF-7909134—1). NTIS, PC A03/MF A01.

From Consultant symposium on rare gases in metals and ionic solids; Harwell, UK (10 Sep 1979).

Cavity (void) formation and swelling in non-fissile materials during neutron irradiation and charged particle bombardments are reviewed. Helium is the most important inert gas and is primarily active as a cavity nucleant. It also enhances formation of dislocation structure. Preimplantation of helium overstimulates cavity nucleation and gives a different temperature response of swelling than when helium is coimplanted during the damage process. Helium affects, and is affected by, radiation-induced phase instability. Many of these effects are explainable in terms of cavity nucleation on submicroscopic critical size gas bubbles, and on the influence of the neutral sink strength of such bubbles. Titanium and zirconium resist cavity formation when vacancy loops are present.

24424 Effect of open porosity on the re-solution of fission gas from grain-edge bubbles. Tucker, M.O.; Turnbull, J.A. (Brookhaven National Lab., Upton, NY). *J. Nucl. Mater.;* **83**: No. 2, 278-285(Sep 1979).

The model of fission gas release from UO_2 fuel during irradiation has been modified to include the effects of the presence of grain-edge porosity on the overall level of re-solution of gas atoms from grain boundaries. The consequence of this improvement is to enhance the predicted fractional gas release at high burn-up.

CERAMICS, CERMETS, AND REFRACTORIES

REFER ALSO TO CITATION(S) 23417, 24019

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 24158, 24161, 24433, 24435, 24437

24425 Chemical vapor deposition of sialon. Landingham, R.L.; Casey, A.W. US Patent Application 040,810. [nd]. 8p.

A laminated composite and a method for forming the composite by chemical vapor deposition are described. The composite includes a layer of sialon and a material to which the layer is bonded. The method includes the steps of exposing a surface of the material to an ammonia containing atmosphere; heating the surface to at least about 1200°C; and impinging a gas containing N_2, $SiCl_4$, and $AlCl_3$ on the surface.

24426 Method of forming single crystals of beta silicon carbide. Lundberg, L.B. US Patent Application 037,247. [nd]. 8p.

A method of growing single crystals of beta SiC from solution using molten lithium as a solvent for polycrystalline SiC feed

material. Reasonable growth rates are accomplished at temperatures in the range of about 1330°C or about 1500°C.

24427 Silicon-nitride and metal composite. Landingham, R.L.; Huffsmith, S.A. US Patent Application 047,597. [nd]. 8p.

A composite and a method for bonding the composite are described. The composite includes a ceramic portion of silicon nitride, a refractory metal portion and a layer of $MoSi_2$ indirectly bonding the composite together. The method includes contacting the layer of $MoSi_2$ with a surface of the silicon nitride and with a surface of the metal; heating the layer to a temperature below 1400°C; and, simultaneously, compressing the layer such that the contacting is with a pressure of at least 30 MPa. This composite overcomes useful life problems in the fabrication of parts for a helical expander for use in power generation.

24428 (PB—301409) Research on electrodes and electrolyte for the Ford sodium-sulfur battery. Annual report 30 June 1976-31 October 1977. Topouzian, A. (Ford Motor Co., Dearborn, MI (USA). Research Staff). Apr 1978. 394p. NTIS, PC A17/MF A01.

In this report, research findings at the University of Utah are reported on the (1) fabrication of pre-sintered beta double prime-Alumina tubing, (2) sintering processes for beta double prime-Alumina, (3) characterization of beta double prime-Alumina, and (4) development of a metal clad electronic ceramic (rutile) container or current collector; as well as additional results on topics treated in prior reports. Research reported from Ford Research Staff covers (1) testing of three series of metal prototype cells, (2) development of procedures for alpha-to beta double prime-Alumina and container sealing, (3) sulfur electrode development (shape and surface treatment), (4) materials screening and development of containers including surface treatment and coating, and (5) evaluation of battery requirements (energy, power, volume, weight) for passenger cars. Research reported by RPI covers (1) the kinetics of the sulfur electrode, (2) physical property measurements, (3) mass transport studies, (4) mechanisms of ceramic degradation, and (5) development of new seal glasses.

24429 (SAND—80-0215) Glass-ceramics for lightning arrestor connector seals. Leedecke, C.J. (Sandia Labs., Albuquerque, NM (USA)). Mar 1980. Contract AC04-76DP00789. 29p. NTIS, PC A03/MF A01.

High dielectric constant glass-ceramics were developed for the use in lightning arrestor connectors. Ferroelectric glass-ceramics were formulated in the $Na_2O.Nb_2O_5.Al_2O_3.SiO_2$ and $Bi_2O_3.TiO_2.B_2O_3$ systems. The most effective nucleating agents for producing $NaNbO_3$ in the $Na_2O.Nb_2O_5.Al_2O_3.SiO_2$ system were SiC and Si. Glass-ceramics based on this sytem have a fine-grained structure, zero porosity when heat-treated in air, and dielectric constants at 100 kHz of up to 70. Glass-ceramics in the $Bi_2O_3.TiO_2.B_2O_3$ system contain the ferroelectric $Bi_4(TiO_4)_3$ phase. These glass-ceramics have dielectric constants of 85 which are frequency independent in the 10^2 to 10^5 Hz region. Upon crystallization, virtually all of the TiO_2 is in the $Bi_4(TiO_4)_3$ phase. The formation of hermetic seals in an Ar atmosphere was hampered by porosity.

24430 (SAND—80-0427C) Shock compaction of a porous pyrotechnic material. Lee, L.M.; Schwarz, A.C. (Sandia Labs., Albuquerque, NM (USA); Ktech Corp., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 18p. (CONF-800713—5). NTIS, PC A02/MF A01.

From 7. international pyrotechnics seminar; Vail, CO, USA (14 Jul 1980).

The results of an experimental program to generate Hugoniot data for an unreacted pyrotechnic material are discussed and the data presented. The program included both sample fabrication and experimental determination of stress-particle velocity Hugoniot data for the pyrotechnic, titanium hydride-potassium perchlorate (TiH_2-$KClO_4$), at two densities. The TiH_2-$KClO_4$, which was supplied as a powder mixture, was pressed to the desired bulk sample density and size using a ram and die technique. Samples were produced with nominal 2.02 or 2.27 g/cm^3 densities. Hugoniot data were generated on the porous pyrotechnic samples using standard flat plate impact techniques. The experimental program provided information defining the shock compaction behavior of porous TiH_2-$KClO_4$ up to 70 kbar. The Hugoniot data for both sample densities indicated full compaction was achieved in the 15 to 20 kbar stress range.

24431 Formation of Ohmic contacts in semiconducting oxides. Narayan, J.; Shukla, V.N. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *J. Appl. Phys.;* **51**: No. 6, 3444-3446(Jun 1980).

A new technique based on deposition of metallic film at room temperature followed by laser irradiation, for the formation of Ohmic Contacts on semiconducting oxides, has been developed. Aluminum or nickel film about 1 μm thick was deposited on n-type polycrystalline barium titanate ($BaTiO_3$) substrates and irradiated with Q-switched ruby laser pulses. This technique produces low-resistance Ohmic contacts which do not age and remain stable over a wide temperature range.

24432 Grain-boundary diffusion in uranium dioxide: the correlation between sintering and creep and a reinterpretation of creep mechanism. Reynolds, G.L.; Burton, B. (Brookhaven National Lab., Upton, NY). *J. Nucl. Mater.;* **82**: No. 1, 22-25(Jun 1979).

Previously published data on the final stage sintering kinetics of stoichiometric uranium dioxide are correlated with a reinterpretation of low-stress creep behavior of identical material (data on both processes by the present authors). For both processes the rate-controlling diffusional flux is considered to be that of uranium ions along grain boundaries. The effective diffusion coefficient for uranium ion diffusion along grain boundaries is estimated. Comparisons are made between this value and those previously measured by radio-tracer methods.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 24050, 24223, 24382, 24383, 24384

24433 Improved structural silicon nitride materials containing rare earth oxides. Anderson, C.A. US Patent Application 001,033. [nd]. 17p.

A ceramic composition suitable for use as a high-temperature structural material in apparatus exposed to oxidizing atmospheres at temperatures of 400 to 1600°C is described. It is found within the triangular area ABCA of the Si_3N_4-SiO_2-M_2O_3 ternary diagram. M is selected from the group of Yb, Dy, Er, Sc, and alloys having Yb, Y, Er, or Dy as one component and Sc, Al, Cr, Ti, (Mg + Zr) or (Ni + Zr) as a second component. The alloy has an effective ionic radius less than 0.89 A.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 24385, 24432

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 24058, 24221, 24223, 24395, 24425, 24438

24434 Effect of neutron irradiation upon the superconducting critical temperature of some transition-metal carbides, nitrides, and carbonitrides. Dew-Hughes, D.; Jones, R. (Brookhaven National Laboratory, Upton, New York 11973). *Appl. Phys. Lett.;* **36**: No. 10, 856-859(15 May 1980).

Samples of TiN, NbC, and Nb(CN) have been irradiated to various neutron doses in the Brookhaven High Flux Beam Reactor. Their superconducting critical temperatures are reduced at a rate which is much less than that for similarly irradiated high-T/sub c/ A15 superconductors. A dose of 1.5 x 10^{20} n/cm^2 (E>1 MeV) causes a reduction in T/sub c/ of 6—27%. This reduction may be explained in terms of the production of metal-lattice vacancies.

24435 High Na^+-ion conductivity in $Na_5YSi_4O_{12}$. Hong, H.Y.P.; Kafalas, J.A.; Bayard, M. (Massachusetts Inst. of Tech., Lexington). pp 2-4 of Twenty-eighth power sources symposium. Princeton, NJ; Electrochemical Society, Incorporated (1978).

From Power sources symposium; Atlantic City, NJ, USA (12 Jun 1978).

High Na^+-ion conductivity is reported in $Na_5YSi_4O_{12}$, in which a rigid cation-anion network is composed of YO_6 and NaO_6 octahedra and SiO_4 and NaO_4 tetrahedra. Procedures for synthesis are described. Complex impedance measurements using gold blocking electrodes were made as a function of temperature; the results obtained at room temperature are shown for the frequency range 3 kHz to 108 MHz. The dependence of conductivity on temperature from 25 to 320°C is shown in a plot of log (sigma T) vs 1/T. Values of conductivity up to 0.15 Ω^{-1} cm^{-1} were obtained. 2 figures. (RWR)

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 24221, 24223, 24427, 24433

24436 (PB—301095) Refractory materials for coal fueled mhd power generation. Final report. Ure, R.W. Jr. (Utah Univ., Salt Lake City (USA). Dept. of Materials Science and Engineering). 30 Jun 1976. 150p. NTIS, PC A07/MF A01.

Research studies to develop improved materials for the preheater and MHD duct for a coal-fired MHD power generator used as a topping unit on a central station power plant are reported. More efficient methods of energy conversion require high temperatures which in turn necessitate better corrosion and erosive resistant materials for use in the MHD duct as electrodes and insulators. Twelve refractory materials were tested for corrosion resistance in

molten slag. Two methods were employed: (1) immersing a rotating rod of the refractory being tested in molten slag at the testing temperature, and (2) using the Thermospray Test in which a commercial flame spray gun sprays hot slag-seed onto the heated refractory specimens through a hole in the heated furnace wall. The AD-998 alumina and MgAl2O4 spinel exhibited the best corrosion resistance. Electron emission from coal slags was investigated since large current densities are required for efficient operation of the MHD duct. Extensive graphs, tables, diagrams and references are included.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 24434

24437 (MLM—2711(OP)) **X-ray induced auger electron spectroscopic studies on aluminum metal surface films in aluminum/iron oxide thermites.** Wang, P.S.; Haws, L.D.; Peters, J.A. (Mound Facility, Miamisburg, OH (USA)). 1980. Contract AC04-76DP00053. 16p. (CONF-800713—9). NTIS, PC A02/MF A01.

From 7. international pyrotechnics seminar; Vail, CO, USA (14 Jul 1980).

The aluminum and iron oxide surfaces of Al/Fe_3O_4 thermite in powder and pressed pellet form were studied before and after accelerated aging at 180°C by x-ray photoelectron spectroscopy (XPS). The Al_2O_3 surface film thicknesses on Al metal were deduced from the intensity ratio of Al K-LL Auger signals induced by x-ray radiation on Al_2O_3 and Al metal. Based on the mean free path of 16.5 A for Al KLL Auger electrons, the oxide thickness on aluminum flakes before mixing with $Fe_3OFe_3O_4$ was estimated to be 8-9 A. A slight oxidation was observed on the aluminum surface after mixing with Fe_3O_4 at room temperature. Hot pressing of this mixture at 425°C for 7 minutes increased the oxide film to 31 A. This surface oxide film seemed to protect the Al metal and further aging at 180°C did not cause significant oxide growth. A layer of carboxylate was detected on the aluminum surface from the C ls XPS signal. The presence of an Fe 2p/sub 3/2/ signal indicated the presence of Fe^{+2} and Fe^{+3}. A weak hydroxyl signal was also observed; this was attributed to slight moisture contamination of the Fe_3O_4 surface.

24438 **Radiation-induced conductivity of Al_2O_3: Experiment and theory.** Klaffky, R.W.; Rose, B.H.; Goland, A.N.; Dienes, G.J. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3610-3634(15 Apr 1980).

The steady-state radiation-induced conductivity (RIC) has been measured in single-crystal Al_2O_3 samples maintained at elevated temperatures during continuous irradiation with 1.5-MeV electrons. A theoretical model is presented in which the rapid increases observed in the RIC are correlated with the thermal detrapping of electrons. To account for the decreases in the RIC, additional rate equations describing the thermal quenching of the conductivity by hole release are considered. The RIC data of the undoped samples indicate that hole release from 0.77-eV V^-/sub OH/ centers may be thermally quenching the conductivity.There are several mechanisms other than thermal quenching which could account for the weak decreases in the RIC. These are the LO-phonon scattering of conduction electrons ("large-polaron" mobility) and bulk electron-hole recombination occurring through multiphonon emission.

COMPOSITE MATERIALS

PREPARATION AND FABRICATION

24439 **High temperature concrete composites containing organosiloxane crosslinked copolymers.** Zeldin, A.; Carciello, N.; Kukacka, L.; Fontana, J. US Patent Application 009,624. [nd]. 18p.

High temperature polymer concrete composites comprising about 10 to 30% by weight of a liquid monomer mixture is described. It consists essentially of an organosiloxane polymer crosslinked with an olefinically unsaturated monomer selected from the group consisting of styrene, methyl methacrylate, trimethylolpropane trimethacrylate, triallyl cyanurate, n-phenylmalimide, divinyl benzene and mixtures thereof. About 70 to 90% by weight of an inert inorganic filler system containing silica sand and portland cement, Fe_2O_3, carbon black or mixtures thereof. Optionally a free radical initiator such as di-tert-butyl peroxide, azobisisobyutyronitrile, benzoyl peroxide, lauryl peroxide and other organic peroxides are used to initiate crosspolymerization of the monomer mixture in the presence of the inorganic filler.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 24397

POLYMERS AND PLASTICS

24440 (EPRI-EL—1263) **Flammability of solid polymer cable dielectrics. Final report.** (National Research Council, Washington, DC (USA). Committee on Dielectrics). Nov 1979. 215p. (CONF-771028—). Dep. NTIS, PC A10/MF A01.

From Conference on electrical insulation and dielectric phenomena; Schenectady, NY, USA (17 Oct 1977).

Separate abstracts are prepared for sections in this proceedings of the Workshop on the Flammability of Solid Polymer Cable Dielectrics held October 20, 1977 in Colonie, NY. (FS)

24441 (EPRI-EL—1263, pp 7.1-7.4) **Special reporter comments and questions.** Christian, W.J. (Underwriters Labs., Inc., Northbrook, IL). Nov 1979.

From Conference on electrical insulation and dielectric phenomena; Schenectady, NY, USA (17 Oct 1977).

The state of the art of the basic research in polymer combustion mechanisms, toxicity, types of polymers and fire retardants, and material characterization of polymers are briefly summarized. (FS)

24442 (EPRI-EL—1263, pp 8.1-8.8) **Measurement and meaning of flame retardancy.** Huggett, C. (National Bureau of Standards, Gaithersburg, MD). Nov 1979.

From Conference on electrical insulation and dielectric phenomena; Schenectady, NY, USA (17 Oct 1977).

What is meant by flame retardancy and how to measure it are discussed. (FS)

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 23450, 24166

24443 **High temperature chemically resistant polymer concrete.** Sugama, T.; Kukacka, L.E. US Patent Application 027,689. [nd]. 25p.

High temperature chemically resistant, non-aqueous polymer concrete composites consist of about 12 to 20% by weight of a water-insoluble polymer binder. The binder is polymerized in situ from a liquid vinyl-type monomer or mixture of vinyl containing monomers such as triallylcyanurate, styrene, acrylonitrile, acrylamide, methacrylamide, methyl-methacrylate, trimethylolpropane trimethacrylate and divinyl benzene. About 5 to 40% by weight of a reactive inorganic filler selected from the group consisting of tricalcium silicate and dicalcium silicate and mixtures containing less than 2% free lime, and about 48 to 83% by weight of silica sand/ and a free radical initiator such as di-tert-butyl peroxide, azobisisobutyronitrile, benzoyl peroxide, lauryl peroxide, other orgaic peroxides and combinations to initiate polymerization of the monomer in the presence of the inorganic filers are used.

24444 **Polymer concrete composites for the production of high strength pipe and linings in high temperature corrosive environments.** Zeldin, A.; Carciello, N.; Fontana, J.; Kukacka, L. US Patent Application 025,503. [nd]. 28p.

High temperature corrosive resistant, non-aqueous polymer concrete composites are described. They comprise about 12 to 20% by weight of a water-insoluble polymer binder polymerized in situ from a liquid monomer mixture consisting essentially of about 40 to 70% by weight of styrene, about 25 to 45% by weight acrylonitrile and about 2.5 to 7.5% by weight acrylamide or methacrylamide and about 1 to 10% by weight of a crosslinking agent. This agent is selected from the group consisting of trimethylolpropane trimethacrylate and divinyl benzene; and about 80 to 88% by weight of an inert inorganic filler system containing silica sand and portland cement, and optionally Fe_2O_3 or carbon black or mica. A free radical initiator such as di-tert-butyl peroxide, azobisisobutyronitrile, benzoyl peroxide, lauryl peroxide, other organic peroxides and combinations thereof to initiate crosspolymerization of the monomer mixture in the presence of said inorganic filler.

MECHANICAL PROPERTIES

24445 (BDX—613-2399) **Stress relaxation of cellular silicone material.** Schneider, J.W. (Bendix Corp., Kansas City, MO (USA)). May 1980. Contract AC04-76DP00613. 18p. NTIS, PC A02/MF A01.

Stress relaxation information for cellular silicone materials formed with urea leachable filler is being gathered. Two types of polymers are used in the test: equilibrium type (random copolymer) and condensation type (block copolymer). Each of these was compounded to provide finished materials with nominal apparent densities of 0.34 and 0.52 g/cm³. Three sample variations of 1.17, 1.52, and 2.54 mm nominal thickness were prepared from the lower density product, and two sample variations higher density product. Each of the material/thickness combinations was compressed to nominal compressions of 20 and 40% with nine replicates at each condition. A compression fixture for aging is used to maintain a

specific compression on the cellular sample at room temperature, and a test machine is used to acquire the load data. The load was recorded at initial assembly and at selected times thereafter. A total of 180 specimens are in test, 90 equilibrium type material samples that have been stored 4 years and 90 condensation type material samples that have been stored for 3 years. Each condition for each material type has nine replicates. Of these nine samples, two are 3 year controls, two more are 10 year controls, and five are tested regularly. Current data supports the statement that the time dependent loss of load bearing properties is approximately log-linear, with the major differences found to be between the material types and the two densities of each material type. Extrapolation indicates that at the end of the planned 10-year study, the load retention of all samples will be between 58 and 68% of original; the condensation type material is expected to be superior.

24446 (EPRI-EL—1263, pp 9.1-9.31) **Cable tray fire tests.** Klamerus, L.J.; Nilson, R.H. (Sandia Labs., Albuquerque, NM). Nov 1979.

From Conference on electrical insulation and dielectric phenomena; Schenectady, NY, USA (17 Oct 1977).

Experimental and analytical information to evaluate the adequacy of cable tray spacing are given. A test facility was designed to truly represent the reactor plant area. The smallest cable normally used in a reactor power plant was tested. (FS)

24447 (EPRI-EL—1263, pp 10.1-10.9) **Review of the approaches to improving the flame resistance of wire and cable insulating and jacketing materials.** Bremner, R.O.; Lunk, H.E.; McGowan, E.J. (Raychem Corp., Menlo Park, CA). Nov 1979.

From Conference on electrical insulation and dielectric phenomena; Schenectady, NY, USA (17 Oct 1977).

The basic approaches to attaining improved flame resistance and the tradeoffs in other properties that must be balanced to achieve acceptable flammability characteristics and still meet other performance requirements are reviewed. (FS)

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 24447, 24451

24448 (EPRI-EL—1263, pp 1.1-1.14) **Overview and summary.** Nov 1979.

From Conference on electrical insulation and dielectric phenomena; Schenectady, NY, USA (17 Oct 1977).

Solid polymer dielectrics used as both insultion and jacketing in electric power and distribution cables have good electric properties; low weight and cost; chemical, moisture, and abrasion resistance; flexibility; and general ease of processing. However, while these cables are usually not the source of ignition, when they do burn they accelerate the spread of fire, generate smoke, and toxic and corrosive materials. (FS)

24449 (EPRI-EL—1263, pp 5.1-5.17) **Fire retardant polymers in electrical wire and cable.** Brauman, S.K. (Stanford Research Inst., Menlo Park, CA). Nov 1979.

From Conference on electrical insulation and dielectric phenomena; Schenectady, NY, USA (17 Oct 1977).

Plastics used in wire and cable, uses of wire and cable polymers with flammability standards, inherently fire resistant polymers and their properties, and flammability tests are described. (FS)

DEGRADATION AND EROSION

24450 (EPRI-EL—1263, pp 2.1-2.27) **Polymer combustion mechanisms.** Fristrom, R.M. (Johns Hopkins Univ., Laurel, MD). Nov 1979.

From Conference on electrical insulation and dielectric phenomena; Schenectady, NY, USA (17 Oct 1977).

The combustion of polymers and their chemistry is a complex problem involving solid, liquid, and gas phase reactions under a variety of thermal and compositional environments. Each polymer has its particular degradation route. General trends are outlined and some examples are given. (FS)

24451 (EPRI-EL—1263, pp 3.1-3.47) **Physiological and toxicological aspects of degradation products produced during the combustion of polyvinyl chloride polymers.** Einhorn, I.N.; Grunnet, M.L. (Univ. of Utah, Salt Lake City). Nov 1979.

From Conference on electrical insulation and dielectric phenomena; Schenectady, NY, USA (17 Oct 1977).

A review is presented of studies conducted at the fire scene to determine factors pertaining to human injury or death in fires involving PVC polymers. The nature and concentration of degradation products produced during pyrolysis or oxidation are discussed. (FS)

24452 (EPRI-EL—1263, pp 4.1-4.15) **Smoke and corrosivity.** Gaskill, J.R. Nov 1979.

From Conference on electrical insulation and dielectric phenomena; Schenectady, NY, USA (17 Oct 1977).

The potential for property damage, particularly by corrosion is addressed. PVC thermal degradation products are described. Property damage is insidious and expensive and cleaning methods after PVC fires are described as the speed and effectiveness may determine the extent of damage. (FS)

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 23804, 23807, 23808, 23812, 23814, 23815, 23816, 23817, 23818, 23821, 23824, 24165, 24427

24453 **Coated woven materials and method of preparation.** McCreary, W.J.; Carroll, D.W. US Patent Application 047,445. [nd]. 31p.

Coating of woven materials so that not only the outer surfaces are coated has been a problem. Now, a solution to that problem is by coating with materials, with metals or with pyrolytic carbon. Materials are deposited in Chemical Vapor Deposition (CND) reactions using a fluidized bed so that the porosity of the woven materials is retained and the tiny filaments which make up the strands which are woven (including inner as well as outer filaments) are substantially uniformly coated.

24454 **Optical band gap of hydrogenated amorphous-boron thin films: The effect of thermal treatment.** Cocks, F.H.; Jones, P.L.; Dimmey, L.J. (Department of Mechanical Engineering and Materials Science, Duke University, Durham, North Carolina 27706). DE-AC03-79ET23041. *Appl. Phys. Lett.;* 36: No. 12, 970-972(15 Jun 1980).

Hydrogenated amorphous-boron thin films produced by glow-discharge decomposition of a gas mixture of 3.1 vol. % diborane and 96.9 vol. % hydrogen have been heat treated at 360 and 400 °C. The resulting absorption coefficients and optical band gaps have been measured as a function of heat-treatment time and temperature. Both the absorption coefficients and the optical band gaps of these films can be drastically changed by such treatments. Thermal treatment at 400 °C for 200 h results in a systematic decrease in the optical band gap from 2.19 to 0.90 eV. From quantitative hydrogen analyses it is shown that hydrogen evolution during heating plays a strong role in reducing the apparent optical band gap. These results indicate that it might be possible to optimize theoretical amorphous-boron thin films through the tailoring of the optical band gap by such thermal treatment.

24455 **Method for making hot-pressed fiber-reinforced carbide-graphite composite.** Riley, R.E.; Wallace, T.C. Sr. (to Dept. of Energy). US Patent 4,180,428. 25 Dec 1979. Filed date 23 Jun 1978. 4p.

PAT-APPL-918,258.

A method for the chemical vapor deposition of a uniform coating of tantalum metal on fibers of a woven graphite cloth is described. Several layers of the coated cloth are hot pressed to produce a tantalum carbidegraphite composite having a uniformly dispersed, fine grained tantalum carbide in graphite with compositions in the range of 15 to 40 volume percent tantalum carbide.

24456 **Preparation of hydrosulfides.** Dannenberg, R.O.; Dolezal, H. US Patent 4,156,656. 29 May 1979. Filed date 13 Jun 1978. 3p.

Hydrosulfides of alkali or alkaline earth metals are potentially useful in a variety of commercial applications including recovery of dissolved metals from metallurgical process or waste streams, or for waste water treatment to remove contaminating metals. It has now been discovered, according to the process of the invention, that hydrosulfides of the alkali and alkaline earth metals, particularly sodium, potassium, calcium, barium, and strontium, may be simply and economically prepared by reacting oxides or hydroxides of the metals with sulfur in aqueous media at elevated temperature and pressure. Suitable temperatures and pressures will range from about 200 degrees to 250 degrees C., preferably about 220 degrees C., and about 210 to 560 psig, preferably about 320 psig.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 24376

24457 (DOE/ET/23033—16) **Defect states in plasma-deposited a-Si:H. Final report, February 1979-January 1980.** Knights, J.C. (Xerox Palo Alto Research Center, CA (USA)). 15 Feb 1980. Contract AC03-79ET23033. 33p. NTIS, PC A03/MF A01.

Studies of defects in plasma-deposited, hydrogenated amorphous silicon (a-Si:H), covering the period February 1979-January 1980 are described. Substantial progress has been made in understanding defect structures, their electronic properties and the influ-

ence of doping. The two most significant results are surprising, in one case for simplicity where complexity was expected, and in the other for complexity where simplicity had been presumed. In the first study we have clarified the nature of the defects by showing the connection between luminescence and light induced ESR experiments. The results indicate that dangling bonds having a positive electronic correlation energy are sufficient to explain most of the experimental information. The second study demonstrates the existence of microstructural inhomogeneities, arising from the nucleation and growth of the films. Thus the usual assumption of a uniform alloy with a random distribution of defects must be modified in considering processes such as electrical conduction, trapping, recombination, hydrogen effusion, etc. Of considerable technological and fundamental interest is the influence of doping on the defect behavior. Previous indications that doping introduces defect states have been confirmed. It remains to determine why this behavior occurs, and if there are any means of circumventing the problem.

24458 (SAND—80-8502) **Phase diagram of $NaNO_3/KNO_3$.** Kramer, C.M.; Wilson, C.J. (Sandia National Labs., Livermore, CA (USA)). Apr 1980. Contract EY-76-C-04-0789. 29p. NTIS, PC A03/MF A01.

The binary phase diagram of $NaNO_3$ and KNO_3 was studied using differential scanning calorimetry (DSC). The phase diagram was modeled with regular solution theory. By fitting the model to the minimum melting point of the system, the regular solution parameters and the heats of mixing for solid solutions of $NaNO_3$ and KNO_3 were estimated. Good agreement was obtained between our data for the liquidus, the previously determined liquidus, and the liquidus calculated from the model.

24459 Elastic relaxation associated with the formation and motion of Schottky defects in ionic crystals. Samara, G.A. (Sandia Laboratories, Alburquerque, New Mexico 87185). DE-AC04-76-DP00789. *Phys. Rev. Lett.;* **44**: No. 10, 670-673(10 Mar 1980).

Present results on CsCl-type and earlier work on NaCl-type solid ionic conductors have indicated that the relaxation of the lattice associated with vacancy formation is outward (i.e., the formation volume is greater than the molar volume). This is in qualitative disagreement with available theoretical calculations which show that the relaxation should be inward for all models of ionic vacancies investigated.

24460 Neutron diffraction study of quinolinic acid recrystallized from D_2O: evaluation of temperature and isotope effects in the structure. Takusagawa, F.; Koetzle, T.F. (Brookhaven National Lab., Upton, NY (USA)). *Acta Crystallogr., Sect. B;* **35**: No. 9, 2126-2135(15 Sep 1979).

The structure of quinolinic acid recrystallized from D_2O (2,3-pyridinedicarboxylic acid; $C_7H_3D_2NO_4$) has been refined based on neutron diffraction data measured at four temperatures: 35, 80, 100 and 298°K. The principal temperature dependence in cell constants is observed for the b axis, which is perpendicular to the molecular planes. The refined thermal parameters have been extrapolated by a least-squares procedure, to yield values for T = 0°K which provide estimates of the combined effects of static disorder and zero-point motion. The D atom shifts toward the midpoint of the short intramolecular O...O hydrogen bond when the crystal is cooled, just as was found in an earlier study to occur for the H atom in the undeuterated material. At 100 and 298°K, the D atom is displaced significantly further from the bond midpoint than is the H atom at the same temperature. The magnitude of this isotope effect appears to be independent of temperature. The exchangeable protons in the crystal have not been completely replaced by D; refinement of the D scattering lengths indicates the presence of approximately 2.7% H attached to N(1) and 4.4% H in the short hydrogen bond. The N scattering length has been refined to yield a value of 0.921 (2) X 10^{-11} mm.

PROPERTIES

REFER ALSO TO CITATION(S) 23485, 23486, 23489, 23494, 23819, 24171, 24311, 24453, 24455

24461 (METC/SP—79/10(Pt.2), pp 522-543) **Structural properties of concrete with fly ash.** Jain, K.K. (Regional Engineering Coll., Rourkela, India). 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

The use of concrete with fly ash as a structural material has received increasing attention due to technical and economic reasons. The modern methods for analysis and design of concrete structures and the adoption of limit state concept call for accurate quantitative estimate of several structural properties of the material. The paper describes some research work recently carried out in this field. The effect of fly ash as partial replacement of cement in structural concretes with compressive strength in the range of 182 to 455 kg/cm² is dealt with. Cement was replaced by equal weight of cement sized particles of fly ash and a maximum replacement of 25 percent was tried. Compressive strength, elasticity and dynamic properties were studied over a period of one year for all the mixes and creep of high strength fly ash concrete was observed for 180 days. Concrete mixes with fly ash exhibited lower compressive strength at 7 days but equal strength was obtained at 28 days' age with substantial cement replacement. The coefficient of variation was generally lower for compressive strength of fly ash concretes. Elasticity was found to be slightly higher for mixes with fly ash. The dynamic modulus of elasticity was nearly the same for equal strength and logarithmic decrement was not significantly affected with fly ash content up to the optimum. Fly ash increased the longitudinal pulse velocity of concrete. Creep of fly ash concrete was observed to be always lower. Relationships between different properties have been proposed and it is shown that concrete made with optimum fly ash content has adequate structural properties for large scale applications.

24462 (METC/SP—79/10(Pt.2), pp 564-569) **Hydration development of fly ash cements as measured by the NMR.** Kocuvan, I. (Salonit Anhovo Co., Anhovo, Yugoslavia); Barbic, L.; Ursic, J.; Blinc, R.; Lahajnar, G.; Merljak, P. 1979.

From 5. international ash utilization symposium; Atlanta, GA, USA (25 Feb 1979).

NMR measurements of the hydration development of portland cement-fly ash mixtures provide valuable information. The determination of the spin-lattice relaxation time T_1 for protons of adsorbed water for the dormant period and for the period where the diffusion controlled reaction ceases, makes it possible to compare the surfaces of the calcium sulfoaluminate hydrates, and of the calcium silicate hydrates grown from the time of mixing with water. Different values are obtained for the different compositions and hydration temperatures used. It might be expected that further measurements with different fly ash qualities would provide information about their relative activity in mixtures with portland cement. However, studies of the effect of temperature and composition on its final hydration of fly ash-cement mixtures leads to an entirely different picture. The surface of the calcium silicate hydrates is dominant. At 40°C the development is below the expected minimum for the fly ash mixtures, i.e., below the percentage of the cement content. Thismight be due to an overall percentage of the cement content. This might be due to an overall decrease of the hydration of cement under the influence of fly ash, or, what seems more likely, to the growth of long-fibered CSH phases in the more porous surroundings. Increased tensile and bending strengths reported for cements with fly ash addition could well be attributed to a greater proportion of the long-fibered hydrates. Further temperature increases lead to a greater development of short-fibered CSH phases, and the cement-fly ash mixtures approach remarkably the reference pure cement sample.

24463 (PB—300686) **A study of the permanent effects of elevated temperature on the hydraulic properties of clay. Master's thesis.** Cullen, D.N. (Auburn Univ., AL (USA). Dept. of Civil Engineering). Aug 1979. 86p. NTIS, PC A05/MF A01.

The constant rate of strain consolidometer was employed in the study of the permanent effects of elevated temperature on the hydraulic properties of Georgia kaolinite, Urbana illite, and bentonite. Samples consolidated from a slurry were heat treated at temperatures of 20, 90, and 160 degrees C for twelve hours and tested using the constant rate of strain consolidation technique at 20 degrees C to measure hydraulic conductivity, volume compressibility and thecoefficient of consolidation. The one-way analysis of variance (fixed effects model) was employed to test for significant linear and quadratic temperature effects. The level of statistical significance was determined for each test. Urbana illite demonstrated a significant quadratic temperature effect in terms of hydraulic conductivity, which was maximized by the 90 degree C treatment. The bentonite clay sample was found to have significant temperature effects associated with hydraulic conductivity and volume compressibility. These effects were linear and positive. Georgia kaolinite did not display significant changes in hydraulic properties caused by temperature.

24464 Raman spectroscopy of surface oxides at elevated temperatures. Farrow, R.L.; Nagelberg, A.S. (Sandia Laboratories, Livermore, California 94550). *Appl. Phys. Lett.;* **36**: No. 12, 945-947(15 Jun 1980).

Backscattering Raman spectroscopy is demonstrated to be a useful technique for in situ characterization of oxide films on metals at high temperatures. Data obtained during oxidation at temperatures between 300 and 850 °C are presented for two different iron-based alloys. The sensitivity and specificity of the technique were sufficient to detect the formation of iron oxide films (Fe_2O_3 and Fe_3O_4) less than 150 A in thickness at temperatures below 350 °C. Above 600 °C, the predominant oxide was Cr_2O_3; however, the presence of a few weight percent Mn in a commercial alloy produced a mixed spinel oxide in addition to Cr_2O_3.

24465 Extended x-ray absorption fine structure of NaBr and Ge at high pressure. Ingalls, R.; Crozier, E.D.; Whitmore, J.E.; Seary,

A.J.; Tranquada, J.M. (Department of Physics, University of Washington, Seattle, Washington 98195). *J. Appl. Phys.;* **51**: No. 6, 3158-3163(Jun 1980).

The x-ray absorption spectra of Ge and of Br in NaBr have been measured to pressures of 52 and 21 kbars, respectively, in a boron carbide and diamond anvil cell in which pressure was measured via the ruby-fluorescence technique. Although Bragg peaks from the diamond anvil reduced the accuracy, atomic spacings in both materials could be determined by extended x-ray absorption fine-structure (EXAFS) analysis. Changes in the nearest-neighbor separations in NaBr, and Ge to at least 40 kbars, agreed with literature values, indicating that the EXAFS phase shifts are quite insensitive to such pressures. In addition the near-edge peak positions in the NaBr spectra appeared to readily shift with pressure, which suggests that NaBr may be quite suitable as a pressure standard in future work of this type.

24466 Temperature dependence of the phonon dispersion in Tl_3PSe_4. Fincher, C.R. Jr.; Shapiro, S.M. (Brookhaven National Laboratory, Upton, New York 11973). DE-AC02-76CH00016. *J. Appl. Phys.;* **51**: No. 6, 3212-3215(Jun 1980).

Previous ultrasonic measurements have shown a softening of one of the acoustic-phonon branches in thallium phosphorus selenide (Tl_3PSe_4) when subject to hydrostatic pressure. These measurements also show a 60% softening between room temperature and 90 K. In order to further characterize this material and to investigate the possibility of a phase transition at temperatures less than 90 K, we have used inelastic neutron scattering to measure the phonon dispersion along symmetry directions. The measurements agree well with the ultrasonic measurements previously reported for all branches except the soft ab shear described by the strain component e_6. The ab shear is found to be 60% stiffer than the ultrasonic value with very little temperature dependence.

24467 Optically induced conductivity changes in discharge-produced hydrogenated amorphous silicon. Staebler, D.L.; Wronski, C.R. (RCA Laboratories, Princeton, New Jersey 08540). EY-76-C-03-1286. *J. Appl. Phys.;* **51**: No. 6, 3262-3268(Jun 1980).

Long exposure to light decreases the photoconductivity and dark conductivity of some samples of hydrogenated amorphous silicon (a-Si : H). Annealing above ~150 °C reverses the process. The effect occurs in the bulk of the films, and is associated with changes in density or occupation of deep gap states. High concentrations of P, B, or As quench the effect. Possible models involving hydrogen bond reorientation at a localized defect or electron-charge transfer between defects are discussed. An example is shown where these conductivity changes do not affect the efficiency of an a-Si : H solar cell.

24468 Excitation by light pulses of mechanical vibrations in solids. Hodby, J.W.; Lewis, A.V.; Alexandrou, C.; Schwab, C.; Boatner, L.A. (Clarendon Laboratory, Oxford, United Kingdom). W-7405-ENG-26. *Appl. Phys. Lett.;* **36**: No. 9, 736-738(1 May 1980).

Pulsed light is found to excite the intrinsic mechanical vibration modes of absorbing solid materials. The effect has been studied in seven piezoelectric solids using electrical detection of the vibrations. Arguments are given for a thermal mechanism, and transfer efficiencies of $\sim 10^{-9}$ are found for the conversion of visible energy into the mechanical energy of vibration. If the proposed mechanism is confirmed by further studies, the process should occur in all partially absorbing solid optical components.

24469 Reaction of hydrogen with hydroxyl-free vitreous silica. Shelby, J.E. (Sandia Laboratories, Livermore, California 94550). *J. Appl. Phys.;* **51**: No. 5, 2589-2593(May 1980).

The reacton of hydrogen with hydroxyl-free vitreous silica has been measured for temperatures between 500 and 850 °C, pressures between 0.132 and 5.78 atm, and sample thicknesses between 0.057 and 1.06 cm. The results can be explained by a simple model often used to explain tarnishing reactions. This model assumes that the reaction rate is very fast compared to diffusion, and that a fixed concentration of trapping sites exists in the specimen.

24470 Properties of the one- and two-component electron-hole liquid in stressed Si at T=0. Kirczenow, G.; Singwi, K.S. (Department of Physics and Astronomy, Northwestern University, Evanston, Illinois 60201). *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3597-3603(15 Apr 1980).

We present a calculation of the T=0 properties of the two-component electron-hole liquid (EHL) in <001>-stressed Si, of the EHL in the equilibrium limit in <001>-stressed Si, and of the EHL in <111>-stressed Si. We conclude that a phase separation of the two-component EHL such as that which we have predicted to occur in <111>-stressed Ge is much less likely to occur in <001>-stressed Si. We also discuss the available experimental data for <111>-stressed Si and <001>-stressed Si in the equilibrium limit.

24471 Band structure and thermodynamic properties of He atoms near a graphite surface. Carlos, W.E.; Cole, M.W. (Department of Physics, The Pennsylvania State University, University Park, Pennsylvania 16802). DE-AC02-79ER10454. *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3713-3720(15 Apr 1980).

The energy-band structure and thermodynamic properties (in the noninteracting limit) of He atoms on graphite are calculated. Bound-state eigenvalues ϵ/sub n/ and matrix elements < n vertical-bar V_{01} vertical-bar n' > obtained in scattering experiments are used as input. The validity of the assumptions used to derive these quantities is verified for self-consistency. The results of these calculations differ from earlier studies in that the binding energies are 15 percent smaller and the corrugation is 50 —100 percent larger. The effective mass enhancement m^*/m is 1.06 for ^{4}He and 1.03 for ^{3}He. Agreement with adsorption-isotherm determinations of the chemical potential in the limit of low coverage and temperature is remarkably good for both isotopes. These results, which are consistent with our previous analysis of the potential energy V(r), indicate that band-structure effects cannot be neglected in treating He films on graphite.

24472 Computer-simulated hopping in a random one-dimensional system. Richards, P.M.; Renken, R.L. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3740-3744(15 Apr 1980).

Classical single-particle hopping has been investigated by Monte Carlo calculations for a one-dimensional (1D) lattice with random nearest-neighbor hopping rates Γ distributed as Γ/sup - alpha/ between Ω_1 and Ω_0 in accordance with the recent theory of Bernasconi et al. We find agreement if the minimum rate Ω_1 is finite, but not for $\Omega_1=0$. We show that the predicted $t \to \infty$ ($\omega \to 0$) limit is not reached until extraordinarily long times, much longer than the $5 \times 10^3 \Omega^{-1}_0$ of the simulations; so this, rather than an incorrect theoretical $\omega \to 0$ limit, is the likely cause of the discrepancy. Implications for observance of the predicted conductivity transition in potassium hollandite are discussed.

24473 Asymmetry in the SiO_2 tunneling barriers to electrons and holes. Ng, K.K.; Card, H.C. (Department of Electrical Engineering and Columbia Radiation Laboratory, Columbia University, New York, New York 10027). DE-AC03-79-ET-23049. *J. Appl. Phys.;* **51**: No. 4, 2153-2157(Apr 1980).

The potential barriers of ultrathin (<40 A) SiO_2 layers to electrons and holes tunneling between the semiconductor and the metal have been measured independently on the same MOS samples by a new experimental technique introduced in this paper. The method combines dark measurements of current and capacitance versus voltage with measurements of photocurrent suppression under optical illumination. The results show that the tunneling barriers for holes are consistently much larger than those for electrons.

24474 Barrier heights of evaporated metal contacts on Zn_3P_2. Wyeth, N.C.; Catalano, A. (Institute of Energy Conversion, University of Delaware, Newark, Delaware 19711). *J. Appl. Phys.;* **51**: No. 4, 2286-2288(Apr 1980).

Contact barrier heights are reported for twelve metals on zinc phosphide (Zn_3P_2). The results do not show a simple dependence on metal work function, but correlate with a chemical heat of reaction indicating the importance of chemical bonding at the metal/semiconductor interface.

24475 Observation of resonantly enhanced degenerate four-wave mixing in doped alkali halides. Watkins, D.E.; Figueira, J.F.; Thomas, S.J. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Opt. Lett.;* **5**: No. 4, 169-171(Apr 1980).

We describe the first reported observation of resonantly enhanced phase conjugation through degenerate four-wave mixing (DFWM) in doped alkali halides. We also describe the first reported quantitative comparison of the resonant DFWM process in the infrared with the theory of Abrams and Lind [Opt. Lett. 2, 94 (1978); 3, 205 (1978)]. The comparison for small values of $\alpha_0 L$ is shown to be excellent. For $\alpha_0 L$ in excess of 3, experiment and theory diverge because of pump attenuation by the resonant medium.

24476 Critical test of vibrational dephasing theories in liquids by use of selective, coherent, picosecond Stokes scattering. Harris, C.B.; Auweter, H.; George, S.M. (Department of Chemistry and Materials and Molecular Research Division of Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). W-7405-ENG-48. *Phys. Rev. Lett.;* **44**: No. 11, 737-740(17 Mar 1980).

A picosecond coherent probing technique is used to determine the homogeneous vibrational linewidth in liquids. Isotope effects on the symmetric CH_3-stretching vibration in methanol and acetone provided a sensitive test for various vibrational dephasing theories. Theories based on binary-collision or hydrodynamic models do not correctly account for the observed isotope effect. Exchange theory is shown to be qualitatively consistent with the results.

24477 Band-tail absorption in hydrogenated amorphous silicon. Crandall, R.S. (RCA Laboratories, Princeton, New Jersey 08540). ET-78-C-03-2219. *Phys. Rev. Lett.;* **44**: No. 11, 749-752(17 Mar 1980).

Measurements of the primary and secondary photocurrent for photon energies above 0.58 eV in a-Si:H solar-cell structures determine the absorption coefficient and give information about the density of valence-band-tail states as well as show that holes are mobile deep in the bandgap.

CORROSION, EROSION, AND DEGRADATION

REFER ALSO TO CITATION(S) 24455

RADIATION EFFECTS

24478 X-ray study of lattice strain in boron implanted laser annealed silicon. Larson, B.C.; Barhorst, J.F. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *J. Appl. Phys.;* **51**: No. 6, 3181-3185(Jun 1980).

The strain distribution in boron implanted, laser annealed silicon has been investigated using x-ray Bragg reflection profiles. The 400 Bragg reflection profile from implanted, laser annealed silicon was analyzed, using the dynamical theory of scattering for distorted crystals, to obtain the strain distribution in the implanted layer as a function of depth. The depth distribution of the strain for an implantation dose of 1×10^{16} 35 keV B^+/cm^2, followed by a 1.6 J/cm^2 ruby laser pulse, was found to have a magnitude of -5.8×10^{-3} near the surface and was found to decrease rapidly for depths greater than 0.2 μm. The shape of the depth distribution of the strain was found to be essentially the same as that for the boron distribution after laser annealing.

24479 Steady-state thermally annealed GaAs with room-temperature-implanted Si. Masuyama, A.; Nicolet, M.; Golecki, I.; Tandon, J.L.; Sadana, D.K.; Washburn, J. (California Institute of Technology, Pasadena, California 91125). *Appl. Phys. Lett.;* **36**: No. 9, 749-751(1 May 1980).

Semi-insulating Cr-doped single-crystal GaAs samples were implanted at room temperature with 300-keV Si ions in the dose range of (0.17 - 2.0) x 10^{15} cm^{-2} and were subsequently steady-state annealed at 900 and 950 °C for 30 min in a H_2 ambient with a Si_3N_4 coating. Differential Hall measurements showed that an upper threshold of about 2 x $10^{16}/cm^3$ exists for the free-electron concentration. The as-implanted atomic-Si profile measured by SIMS follows the theoretical prediction, but is altered during annealing. The Cr distribution also changes, and a band of dislocation loops ~2 - 3 kA wide is revealed by cross-sectional TEM at a mean depth of R/ sub p/~3 kA. Incomplete electrical activation of the Si is shown to be the primary cause for the effect.

24480 Effect of radiation on the physical properties of borosilicate glasses. Shelby, J.E. (Sandia Laboratories Livermore, California 94550). *J. Appl. Phys.;* **51**: No. 5, 2561-2565(May 1980).

The effect of gamma ray irradiation on the density, refractive index, thermal expansion, and helium permeability of a variety of commercial borosilicate glasses has been measured for doses between 10^9 and 10^{11} rad. The radiation-induced densification of these glasses for a constant dose can vary by as much as factor of 30 and appears to increase with increasing boron content of the glass. The refractive index also increases with dose and appears to be related to the change in density via the Lorentz-Lorenz equation. The thermal expansion coefficient decreases with increasing dose for any given glass, and appears to vary inversely with the density change on a universal plot of change in thermal expansion coefficient versus change in density. Although the helium permeability was only measured for a few of the glasses, it appears that it is unaffected by radiation-induced compaction of the glass. These effects are believed to result from the phase-separated morphology of these glasses and from the less rigid nature of the network of one of these phases.

24481 Soft x-ray vacuum ultraviolet spectroscopy of thin targets heated by enhanced electron energy deposition. Burns, E.J.T.; Chang, J.; Farnsworth, A.V. Jr.; VanDevender, J.P.; Widner, M.M.; Goldstein, S.A.; Mendel, C.W.; Quintenz, J.P.; Doschek, G.A. (Sandia Laboratories, Albuquerque, New Mexico 87185). DE-ACO4-76-DP00789. *J. Appl. Phys.;* **51**: No. 5, 2569-2573(May 1980).

Soft x-ray vacuum ultraviolet spectroscopy (10—600 eV) has been used to study relativistic electron beam energy deposition in 6-μm Au foils mounted in two different anode geometries. Experimentally determined thermal electron temperatures of 173 eV and 306 eV are in agreement with calculations assuming electron energy deposition rates of 5×10^{13} W/g and 10^{14} W/g for the two geometries. These results are consistent with electrons multipassing through the thin foils several times.

24482 Cathodoluminescence studies of anomalous ion implantation defect introduction in ZnTe. Norris, C.B. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* **51**: No. 4, 1998-2002(Apr 1980).

Depth-resolved cathodoluminescence was employed in conjunction with layer removal by chemical etching in an investigation of the anomalous postrange damage introduction which accompanies shallow ion implantations in ZnTe. 200-keV Xe^+ implantations were performed at substrate temperatures of 300 or 80 K; the latter implant was postannealed at 300 K. The calculated projected range of these implants was 0.05 μm. However, 10- to 1000-fold quenching of the incumbent extrinsic and intrinsic ZnTe luminescence was found at depths of 1—2 μm following both implants. In comparison to the 300 K implant, the 80 K implant and subsequent 300 K anneal introduces postrange defects at a higher concentration and the highly damaged region extends to a greater depth. Injection level dependence measurements show that the predominant effect of the postrange defects is to introduce independent nonradiative recombination centers rather than to react with the incumbent luminescence centers. However, we presently have no clue to the identity of the defect species introduced. In conclusion, we discuss the implications of the anomalous defect introduction for the device technology of ZnTe.

CHEMISTRY

REFER ALSO TO CITATION(S) 25116

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 23697

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 23659, 23683, 23694, 23695

24483 Nondestructive fissile isotopic measurement technique for Uranium-233 - Uranium-235 fuels using prompt and delayed fission neutron counting. Allen, E.J.; McNeany, S.R. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **47**: No. 2, 363-377(Feb 1980).

Assay and analysis procedures were developed for nondestructive fissile isotopic measurement of mixed ^{233}U-^{235}U fuel samples. For ^{233}U, the number of delayed neutrons released per fission is about half that for ^{235}U, although the number of prompt neutrons is approximately the same. By separately counting prompt and delayed neutrons released by a sample exposed to neutron irradiation, the amounts of ^{233}U and ^{235}U present in the sample can be determined. Equations of delayed and prompt neutron counts versus ^{233}U and ^{235}U contents are solved simultaneously for the ^{233}U and ^{235}U contents of a sample. Eleven samples containing mixtures of ^{233}U and ^{235}U from no ^{233}U to nearly 100% were prepared and assayed in prompt and delayed neutron assay devices. Constants for calibration equations were fitted to data from nine of the samples. The maximum differences between counts calculated by the calibration equations and measured counts were 2.3% for delayed neutrons and 1.2% for prompt neutrons, indicating a good selection of the form for the calibration equations. The two remaining samples were treated as unknown, and the uranium contents of these samples were determined by simultaneously solving the two calibration equations. The maximum difference between measured ^{233}U or ^{235}U content and actual content for either sample was 1.%.

24484 Instrumental analysis of trace elements in thumbnails of human subjects. Kanabrocki, E.L.; Kanabrocki, J.A.; Greco, J.; Kaplan, E.; Oester, Y.T. (Veterans Administration Hospital, Hines, IL (USA)); Brar, S.S.; Gustafson, P.S.; Nelson, D.M. (Argonne National Lab., IL (USA)); Moore, C.E. (Loyola Univ., Chicago, IL (USA)). *Sci. Total Environ.;* **13**: No. 2, 131-140(Oct 1979).

Human thumbnails were analyzed for trace elements by instrumental analysis using thermal neutron activation technique. The average concentration of metals studied in clinically symptom-free adult female and male subjects were: zinc, 184 vs. 153 ppm; chromium, 6.8 vs. 4.2; selenium 0.9 vs. 0.6; gold 2.6 vs. 0.4; mercury, 1.9 vs. 0.4; silver, 0.7 vs. 0.3; cobalt, 0.07 vs. 0.04. A summary of literature reported concentration of metals in human nail is also presented.

24485 Activation analysis. Robertson, D.E. (Battelle Pacific Northwest Labs., Richland, WA); Carpenter, R. pp 93-159 of Strategies for marine pollution monitoring. Goldberg, E.D. (ed.). New York, NY; John Wiley and Sons (1976).

This chapter describes the technology and applications of neutron activation analysis (NAA) for the measurement of trace metal constituents in environmental samples, with emphasis on the marine environment. This slightly revised version of National Academy of Sciences-National Research Council Monograph NAS/NS 3114 is organized to indicate which trace elements can normally be measured by nondestructive INAA in the five matrices considered;

when necessary, the chemistry required for preconcentrations and separations is provided. Emphasis has been placed on the measurement of the most potentially hazardous trace metals mercury, cadmium, copper, silver, arsenic, antimony, chromium, selenium, and zinc. Lead and tin are not included, since NAA is not a sensitive method for these elements. The importance of analyzing only samples that have been collected and preserved is stressed to minimize contamination during these operations. Elaborate analyses of samples unrepresentative in time or space can also lead to erroneous conclusions. For both these reasons the need for good communication between the collector and the analyst is emphasized. Precautions found effective in minimizing such undesirable artifacts of handling are discussed by Robertson (1).

CHEMICAL PROCEDURES

24486 (LA—8145) **Modified titrimetric determination of plutonium using photometric end-point detection.** Baughman, W.J.; Dahlby, J.W. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 13p. NTIS, PC A02/MF A01.

A method used at LASL for the accurate and precise assay of plutonium metal was modified for the measurement of plutonium in plutonium oxides, nitrate solutions, and in other samples containing large quantities of plutonium in oxidized states higher than +3. In this modified method, the plutonium oxide or other sample is dissolved using the sealed-reflux dissolution method or other appropriate methods. Weighed aliquots, containing approximately 100 mg of plutonium, of the dissolved sample or plutonium nitrate solution are fumed to dryness with an $HClO_4$-H_2SO_4 mixture. The dried residue is dissolved in dilute H_2SO_4, and the plutonium is reduced to plutonium (III) with zinc metal. The excess zinc metal is dissolved with HCl, and the solution is passed through a lead reductor column to ensure complete reduction of the plutonium to plutonium (III). The solution, with added ferroin inuicator, is then titrated immediately with standardized ceric solution to a photometric end point. For the analysis of plutonium metal solutions, plutonium oxides, and nitrate solutions, the relative standard deviation are 0.06, 0.08, and 0.14%, respectively. Of the elements most likely to be found with the plutonium, only iron, neptunium, and uranium interfere. Small amounts of uranium and iron, which titrate quantitatively in the method, are determined by separate analytical methods, and suitable corrections are applied to the plutonium value. 4 tables, 4 figures.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 23682, 23696

24487 (BNL—27611) **Use of a synchrotron radiation x-ray microprobe for elemental analysis at the National Synchrotron Light Source.** Gordon, B.M. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 9p. (CONF-800433—2). NTIS, PC A02/MF A01.

From 4. international conference on nuclear methods in environment and energy research; Columbia, MO, USA (14 Apr 1980).

The National Synchrotron Light Source (NSLS) is a facility consisting of a 700 MeV and a 2.5 GeV electron storage ring and dedicated to providing synchrotron radiation in the energy range from the vacuum ultraviolet to high energy x rays. Some of the properties of synchrotron radiation that contribute to its usefulness for x-ray fluorescence are: a continuous, tunable energy spectrum, strong collimation in the horizontal plane, high polarization in the storage ring plane, and relatively low energy deposition. The highest priority is for the development of an x-ray microprobe beam line capable of trace analysis in the parts per million range with spatial resolution as low as one micrometer. An eventual capability for bulk sample analysis is also planned with sensitivities in the more favorable cases beings low as 50 parts per billion in dry biological tissue. The microprobe technique has application to a variety of fields including the geological, medical, materials and environmental sciences. Examples of investigations include multielemental trace analysis across grain boundaries for the study of diffusion and cooling processes in geological and materials sciences samples; in leukocytes and other types of individual cells for studying the relationship between trace element concentrations and disease or nutrition; and in individual particles in air pollution samples.

24488 (CONF-791103—111) **Radioactive Materials Analytical Laboratory.** Laing, W.R.; Corbin, L.T. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 7p. NTIS, PC A02/MF A01.

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

The Radioactive Materials Analytical Laboratory was completed 15 years ago and has been used since as an analytical chemistry support lab for reactor, fuel development, and reprocessing programs. Additions have been made to the building on two occasions, and a third addition is planned for the future. Major maintenance items include replacement of $ZnBr_2$ windows, cleanup of lead glass windows, and servicing of the intercell conveyor. An upgrading program, now in progress, includes construction of new hot-cell instrumentation and the installation of new equipment such as an x-ray fluorescence analyzer and a spark source mass spectrometer.

24489 (LA-UR—80-1215) **Ionization chamber for measurements of high-level tritium gas.** Carstens, D.H.W.; David, W.R. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 14p. (CONF-800427—9). NTIS, PC A02/MF A01.

From Tritium technology in fission, fusion, and isotopic application; Dayton, OH, USA (29 Apr 1980).

The construction and calibration of a simple ionization-chamber apparatus for measurement of high level tritium gas is described. The apparatus uses an easily constructed but rugged chamber containing the unknown gas and an inexpensive digital multimeter for measuring the ion current. The equipment after calibration is suitable for measuring 0.01 to 100% tritium gas in hydrogen-helium mixes with an accuracy of a few percent. At both the high and low limits of measurements deviations from the predicted theoretical current are observed. These are briefly discussed.

24490 (RFP—3090) **Determination of plutonium isotopic content by passive gamma spectrometric methods.** (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 1980. Contract AC04-76DP03533. 17p. NTIS, PC A02/MF A01.

The many advantages of being able to determine the isotopic content of plutonium samples by gamma spectrometric methods have already been discussed, the primary one being that this analytical technique is nondestructive. It is thought that the accuracy can be improved even more by improvements in the spectral software. Probably the most important conclusion to be drawn is that this method of analysis has now taken its place as an analytical technique alongside mass spectroscopy.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 23682, 23683, 23694, 23695, 24651

24491 (Y—2205) **Evaluation of a laser-induced fluorescence system for uranium analysis.** White, L.E. (Oak Ridge Y-12 Plant, TN (USA)). May 1980. Contract W-7405-ENG-26. 19p. NTIS, PC A02/MF A01.

A laser-induced fluorescence method for total uranium analysis of industrial process waters, waste waters, and leachates has been evaluated as a possible alternative for the normal, sodium fluoride and lithium fluoride, flame-fusion fluorescence method currently employed. Since the lower reporting limit of the laser fluorometer is on the order of 0.05 μg/L, samples for normal analysis can usually be diluted from 100 to 1000 fold which virtually eliminates interferences from quenching substances. Also, since the uranium determination is done in aqueous solution, laser-induced fluorescence entirely eliminates the need for organic extraction and the subsequent fusion process.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 23700, 23834

24492 **System for loading slab-gel holders for electrophoresis separation.** Andersen, N.G.; Anderson, N.L. (to Dept. of Energy). US Patent 4,169,036. 25 Sep 1979. Filed date 24 Mar 1978. 6p.

A slab-gel loading system includes a prismatic chamber for filling a plurality of slab-gel holders simultaneously. Each slab-gel holder comprises a pair of spaced apart plates defining an intermediate volume for gel containment. The holders are vertically positioned in the chamber with their major surfaces parallel to the chamber end walls. A liquid inlet is provided at the corner between the bottom and a side wall of the chamber for distributing a polymerizable monomer solution or a coagulable colloidal solution into each of the holders. The chamber is rotatably supported so that filling can begin with the corner having the liquid inlet directed downwardly such that the solution is gently funneled upwardly, without mixing, along the diverging side and bottom surfaces. As filling proceeds, the chamber is gradually rotated to position the bottom wall in a horizontal mode. The liquid filling means includes a plastic envelope with a septum dividing it into two compartments for intermixing two solutions of different density and thereby providing a liquid flow having a density gradient. The resulting gels have a density gradient between opposite edges for subsequent use in electrophoresis separations.

24493 (DP-TR—9) **Effect of the degree of hydration of the adsorbent on the chromatographic analysis of common gases.** Aubeau, R.; Leroy, J.; Champeix, L. Translated from *J. Chromatogr.*; **19**: 249-262(1965). 14p. NTIS, PC A02/MF A01.

The chromatographic spectrum in a five angstrom molecular sieve of a mixture of H_2-O_2-N_2-CH_4-CO-Kr-Xe depends greatly on the water content of the adsorbent and its heat treatment. Retention

time of these gases generally decreases when the hydration rate increases. This effect is especially marked for CO but is weak for the rare gases. By virtue of this fact, according to the hydration rate of the adsorbent, krypton, and xenon can be perfectly separated or may be mixed with their neighbors in the spectrum. The displacement of different peaks in the spectrum, when the hydration rate of the adsorbent increases, can be interpreted by considering (1) the corresponding evolution of heats of adsorption and (2) the reduction in free surface of the hydrated adsorbent. Treatment of the molecular sieve at 600°C involves a decrease in column efficiency for each gas. The results allows one to easily determine the optimum conditions for separation of common gases on a five angstrom molecular sieve.

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 23593, 24170, 24171

24494 (GEPP-OP—474a) **New technique for determining the parameters of gas permeation through solids.** Kohls, J.F. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 1980. Contract AC04-76DP00656. 31p. (CONF-800538—4). NTIS, PC A03/MF A01.

From ACS meeting-in-miniature; Tampa, FL, USA (8 May 1980).

The solution of Fick's equation for gas permeation through solid flat membranes yields a throughput rate equation with two unknown parameters, diffusivity and solubility. The common methods used to evaluate these parameters rely on knowing the equilibrium throughout rate. This equilibrium rate is in some cases rapidly established (on the order of seconds), in other cases slowly established (order of months). Thus, permeation measurements may require equipment usage over a long time period, precluding its use for other experience. A mathematical technique for predicting the permeation parameters using the unequilibrated portion of the permeation throughout curve has been developed which overcomes this difficulty. The method developed (termed stabilized search) was tested with data simulated using a known amount of error. The predicted parameters were as accurate as the data, but the values were generated in only 20 to 40% of the time required for other methods.

24495 (GEPP-OP—482) **Gettering of carbon dioxide by erbium thin films.** Mehrhoff, T.K. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 1980. Contract AC04-76DP00656. 41p. (CONF-800538—1). NTIS, PC A03/MF A01.

From ACS meeting-in-miniature; Tampa, FL, USA (8 May 1980).

The interaction of carbon dioxide and erbium thin films is characterized at 300 to 900°C and 5 x 10^{-7} torr. Temperature ramp experiments with thin erbium films indicated a significant reaction above 300°C, preceded by desorption of water vapor, hydrogen and nitrogen and/or carbon monoxide from the film surface. The sticking coefficients were plotted as a function of Langmuirs of carbon dioxide exposure. Between 400 and 600°C, the length of the exposure was found to be more important than the temperature of the exposure in determining the sticking coefficient. Some evolution of carbon monoxide was noted particularly in the 400 to 500°C region. An 80% conversion of carbon dioxide to carbon monoxide was measured at 500°C. The film pumping speeds were compared with published vapor pressure data for erbium. This comparison indicated that a significant portion of the pumping action observed at temperatures of 800°C and above was due to evaporation of erbium metal.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

24496 **Molecular hydrogen exchange: A study of** $HD(v=5)+HD(v=0)\rightarrow H_2+D_2$. Herman, I.P. (Physics Department, University of California Lawrence Livermore Laboratory, Livermore, California 94550). W-7405-ENG-48. *J. Chem. Phys.;* **72**: No. 10, 5777-5778(15 May 1980).

A likely bimolecular pathway for the reaction $HD(v=5)+HD(v=0)\rightarrow H_2+D_2$ at room temperature is investigated by cw intercavity dye laser excitation, followed by measurement of the D_2 photoproduct. (AIP)

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 23420, 23593, 23598, 23718, 24503, 24812

ISOTOPE EFFECTS

REFER ALSO TO CITATION(S) 24476

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

24497 **Deuterium separation at high pressure by nanosecond CO_2 laser multiple-photon dissociation.** Marling, J.B.; Herman, I.P.; Thomas, S.J. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *J. Chem. Phys.;* **72**: No. 10, 5603-5634(15 May 1980).

Photochemical deuterium separation is evaluated at pressures up to 1 atm using 2 ns duration CO_2 laser pulses to achieve multiple-photon dissociation (MPD) as the isotopic separation step. Photochemical performance is compared for Freon 123 (2,2-dichloro-1,1,1-trifluoroethane), difluoromethane, and trifluoromethane based on deuterium optical selectivity in absorption, photoproduct yield, and single-step deuterium enrichment factor. The absorption coefficient versus energy fluence is measured from 0.01 to 3 J/cm² fluence for CF_3CDCl_2, CDF_3, and $CHDF_2$; added buffer gas results in an order-of-magnitude increase in the CDF_3 absorption coefficient. The deuterium optical selectivity in absorption at 0.5 J/cm² fluence with added buffer is 80 for CF_3CDCl_2 at 10.65 μ, 800 for $CHDF_2$ at 10.48 μ, and 2500 for CDF_3 at 10.21 μ. The absorption coefficients and hence optical isotopic selectivities are dependent on fluence, and the optical selectivity attains a maximum value of 8000 for CDF_3 below 0.01 J/cm² fluence. The deuterium-bearing MPD photoproducts at high pressure are trifluoroethylene for Freon 123, hydrogen fluoride for trifluoromethane, and both hydrogen fluoride and monofluoroacetylene for difluoromethane. Yield data determined by gas chromatography are analyzed using a model describing MPD due to a focused Gaussian beam in an absorbing medium to remove compositional and geometrical effects; this analysis results in a saturation fluence (at which the dissociation probability approaches 100%) of 12 +- 2 J/cm² for CF_3CDCl_2, 20 +- 2 J/cm² for CDF_3 buffered by 1 atm argon, 30 +- 2 J/cm² for CDF_3 buffered by 60—400 Torr CHF_3, and 22 +- 3 J/cm² for $CHDF_2$ buffered by 100—400 Torr CH_2F_2.

ELECTROCHEMISTRY

REFER ALSO TO CITATION(S) 24122, 24170

24498 (COO—4881-3) **Energy savings by means of fuel cell electrodes in electro-chemical industries. Progress report, August 1-October 31, 1978.** Allen, R.J.; Juda, W.; Lindstrom, R.W. (Prototech Co., Newton Highlands, MA (USA)). Dec 1978. Contract ET-78-C-02-4881. 69p. Dep. NTIS, PC A04/MF A01.

Caustic half cells are described and data reported for tests run to evaluate the technology involved in the operation of air cathodes for the Caustic-Chlorine Industry. The majority of tests were run at 300 ASF in a 23% NaOH electrolyte at 75°C with a CO_2 free air efficiency of 33%. Data are presented for a 7200-h life test which is in operation and represents the state of the art. Runs have been made to identify the limiting current density and air efficiency for the standard RA19 type air cathode. Also presented are tests involving cell temperature, electrode platinum variation and evaluation of several thin, porous, conducting substrates on which the catalyst layer is deposited during electrode fabrication. Technical data on advisory meetings and experimental cell design for hydrogen anode evaluation in the electrowinning of zinc were reported. Preliminary results demonstrate a savings of over 0.6 kWh/lb of zinc for 3 to 4 hours runs employing pure hydrogen as fuel and a 0.33 mg/cm² Pt anode. In the area of metal-water-air batteries a consultatory meeting was held, and the initial data obtained at Lawrence Livermore Laboratory for a standard Prototech Company air cathode in an Aluminum-Air Battery were reported to be most encouraging.

PHOTOCHEMISTRY

REFER ALSO TO CITATION(S) 24496

24499 (DOE/ER/01198—1305) **Photophysics of organic molecules at high pressure.** Mitchell, D.J. (Illinois Univ., Urbana (USA). Dept. of Chemical Engineering). 1978. Contract AC02-76ER01198. 140p. Dep. NTIS, PC A07/MF A01.

Thesis.

The pressure dependence of emission intensities, energies, and lifetimes of several classes of organic compounds in plastic media were investigated over the range 0-140 kilobars. The fluorescence intensity of 9-anthraldehyde, 9-acetylanthracene, and 9-benzoylanthracene increases remarkably with increasing pressure, accompanied by a large red shift in the emission spectrum. For azulene and several derivatives, the efficiency of fluorescence from both the second and

first excited singlet states was pressure dependent as was the relative energy of these states. The rate of internal conversion depended strongly on the energy separating the relevant states. The energy and quantum efficiency of fluorescence for fluorenone in crystalline form and in several polymeric matrices was measured as a function of pressure. The quantum yield, ranged from 0.001 at low pressure to a maximum of about 0.1 at high pressure in paraffinic plastics. Fluorescence quantum yields and phosphorescence quantum yields and lifetimes were measured for pyrazine (P) 2,6-dimethylpyrazine and tetramethylpyrazine (TMP) in PMMA over the pessure range 20-120 kbar. An additional emission, which is attributed to excimer fluorescence, was also observed for these samples and for crystalline pyrazine. The phosphorescence radiative lifetime for P and TMP was about 18 ms.

24500 Electrochemical light-emitting diodes. Butler, M.A.; Ginley, D.S. (Sandia National Laboratories, Albuquerque, New Mexico 87185). DE-AC04-76-DP00789. *Appl. Phys. Lett.;* **36**: No. 10, 845-847(15 May 1980).

Luminescence has been observed at a p-GaP/electrolyte interface in several different electrolytes. A new mechanism, direct injection of ions into the semiconductor surface, is shown to be responsible for the luminescence. Experimental results for the luminescence spectral response, current dependence, time dependence, and ion dependence will be presented. Elastic recoil detection experiments have directly observed the injected ions.

24501 Upper limit to the excited electron-cation recombination lifetimes of trapped electrons in ethanol and 2-methyl-tetrahydrofuran glasses at 4 and 77 K. Ogasawara, M.; Kevan, L. (Wayne State Univ., Detroit, MI). Contract E(11-1)-2086. *Bull. Chem. Soc. Jpn.;* **51**: No. 10, 2762-2764(Oct 1978).

N,N,N',N'-Tetramethyl-p-phenylenediamine (TMPD) fluorescence lifetimes in 2-methyltetrahydrofuran (MTHF) glass at 77 K (13.5 ns) and in ethanol glass at 77 K (12.3 ns) and 4 K (11.5 ns) were measured using 347 nm excitation from a frequency doubled ruby laser. Trapped electrons and $TMPD^+$ were generated in these matrices by photoionization and the recombination fluorescence stimulated by 694 nm laser light was found, within an experimental limit of 1 ns, to occur with the same lifetime as the directly excited fluorescence. A convolution analysis indicates that the electron-cation recombination lifetimes are $\leqq$ 1 ns in all these matrices at the temperatures given. It is also suggested that lower limit for the electron mobility of 0.0005 $cm^2V^{-1}s^{-1}$ is implied by these date.

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 23753, 24733, 24735

24502 Oxidation of Ag^+ and $Ag(NH_3)_2^+$ as studied by pulse radiolysis. Kumar, A.; Neta, P. (Univ. of Notre Dame, IN). *J. Phys. Chem.;* **83**: No. 24, 3091-3095(29 Nov 1979).

The reaction of OH radicals with Ag^+ forms $AgOH^+$ which then undergoes the acid-base equilibrium Ag^{2+} reversible $AgOH^+$ reversible $Ag(OH)_2$. The decay of all these Ag/sup II/ species leads to the formation of Ag/sup I/ and Ag/sup III/ ions. However, while the disproportionation of Ag^{2+} is a direct process, the reactions of $AgOH^+$ and $Ag(OH)_2$ involve certain intermediates. These relatively long-lived intermediates are suggested to be dimeric complexes, in which two silver atoms are bridged via OH groups, with a possible formation of trimers or tetramers. The decay of these intermediates produces Ag/sup III/ions. The spectra of the Ag/sup III/ ions vary with pH and suggest the presence of Ag^{3+}, $Ag(OH)^{2+}$, and $Ag(OH)_2^+$ at different pH values (4 to 10). The Ag/sup III/ ions also disappear over several seconds, presumably reacting with water. The $Ag(NH_3)_2^+$ ion reacts rapidly with OH, and almost as rapidly with NH_2 radicals ($k = 4 \times 10^9\ M^{-1}\ s^{-1}$). The radicals add to the silver to form Ag/sup II/ species which can take up more NH_3 to form $Ag(NH_3)_3OH^+$ and $Ag(NH_3)_4^{2+}$ or an equilibrium mixture of these two complex ions. By varying the NH_3 and OH^- concentrations and following the spectral changes of the Ag/sup II/ ions, an equilibrium constant for $Ag(NH_3)_3OH^+ + NH_3$ reversible $Ag(NH_3)_4^{2+} + OH^-$ of 0.1 was determined, and the rate constants of the reaction to the right were measured to be $8 \times 10^6\ M^{-1}\ s^{-1}$. The decay of $Ag(NH_3)_4^{2+}$ follows second order with $2k = 1.2 \times 10^6\ M^{-1}\ s^{-1}$. The resulting Ag/sup III/ complex apparently absorbs only below 250 nm and was not observed. No intermediate spectra were observed during this decay.

24503 process for coating a substrate with a radiation and moisture curable coating composition. Noomen, A.; van der Geest, J.M.P.; de Jong, C.; Santen, D.V. (to Akzo N.V.). US Patent 4,173,682. 6 Nov 1979. Priority date 9 Mar 1977, Netherlands, 10p.

A process is disclosed for coating a substrate with a radiation curble coating composition, characterized in that the composition comprises (A) an at least one isocyanate group-containing adduct of (a) an acrylic or methacrylic hydroxy ester with 5 to 20 carbon atoms and (b) a polyisocyanate with 4 to 40 carbon atoms and with 2 to 4 isocyanate groups per molecule, (B) a polyfunctional hydroxy compound having a molecular weight of 178 to 12,000 and a hydroxyl content of 0.5 to 30% by weight in an amount of 0.5 to 1.5 equivalents of hydroxy per equivalent of isocyanate of component A, and (C) a photoinitiator in an amount of 0.1 to 10% by weight of component A. The curing takes place in a first stage by radiation having a wavelength of 90 to 600 nm and in a second stage by reaction of the isocyanate groups of component A with water vapor and the hydroxyl groups of the polyfunctional hydroxy compound.

24504 (DOE/EV/03221—66) Iron hexacyanide/cytochrome-C - intramolecular electron transfer and binding constants - (pulse radiolytic study). Progress report. Ilan, Y.; Shafferman, A. (Israel Inst. for Biological Research, Nes Ziona). [nd]. Contract AC02-76EV03221. 12p. NTIS, PC A02/MF A01.

Internal oxidation and reduction rates of horse cytochrome-c in the complexes, CII.Fe/sup III/$(CN)^{-3}{}_6$ and CIII.Fe/sup II/$(CN)^{-4}{}_6$, are $4.6.10^4 s^{-1}$ and $3.3.10^2 s^{-1}$, respectively. The binding sites of the iron hexacyanide ions on either CII or CIII are kinetically almost indistinguishable; binding constants range from $0.87.10^3$ to $2.10^3 M^{-1}$. The present pulse radiolytic kinetic data are compared with that from N.M.R, T-jump and equilibrium dialysis studies.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

PROPERTIES OF RADIOACTIVE MATERIALS

24505 (GEPP-OP—501) Evaluation of ultrasonic cleaning systems. Gillespie, T.J. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 1980. Contract AC04-76DP00656. 11p. (CONF-800538—3). NTIS, PC A02/MF A01.

From ACS meeting-in-miniature; Tampa, FL, USA (8 May 1980).

Several methods for evaluating ultrasonic cleaners were tested, including pencil-marked ceramic, Al foil erosion, Branson cavin meter, etc. A method was devised which involves applying a thin metallize coating to a ceramic plate. This method was used to evaluate new ultrasonic cleaners. 6 figures. (DLC)

COMBUSTION, PYROLYSIS, AND HIGH-TEMPERATURE CHEMISTRY

REFER ALSO TO CITATION(S) 24580

24506 Burner equipment and operation thereof. Moss, G.; Johnes, G.L.; William, J.; Craig, T. US Patent 4,043,741. 23 Aug 1977. Filed date 11 Mar 1976. 8p.

Fuel gas produced e.g. in a fluid bed gasifier and which comprises deposit-forming materials such as heavy hydrocarbons (e.g. tars) and non-combustible fines is passed via conduits and solid-removing cyclones to a burner for admixture with air and subsequent combustion. Deposits formed in the conduits cyclones and burner are removed by closing off the burner outlet and air inlet, and passing a deposit-removing reactant (e.g. air) into the conduit to oxidize and thereby remove deposits, particularly from the cyclones. Preferably, there are at least two burners for the fuel gas, and they are closed off alternately to remove depsites from their respective conduits and cyclones.

ENGINEERING

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 24783

24507 (ANL/MSD/FE—80-2) Development of nondestructive evaluation techniques for high-temperature ceramic heat exchanger components. Tenth quarterly report, January-March 1980. Kupperman, D.S.; Yuhas, D.; Caines, M.J. (Argonne National Lab., IL (USA)). Apr 1980. Contract W-31-109-ENG-38. 22p. NTIS, PC A02/MF A01.

The effectiveness of several conventional and unconventional NDE techniques for specific high-temperature ceramic components was determined. Techniques under study at ANL include dye-enhanced radiography, acoustic microscopy, conventional ultrasonic testing, acoustic-emission detection, acoustic impact testing, holography, interferometry, infrared scanning, internal friction measurements, and overload proof testing. The current effort involves SiC

heat-exchanger tubes; previous ceramic NDE efforts at ANL have involved silicon-nitride gas-turbine rotors. Recent results on inspection of SiC heat-exchanger tubing by means of ultrasonic acoustic microscopy techniques and efforts initiated and planned for NDE of ceramic joints are discussed.

24508 (BDX—613-2375) **Semiautomated inspection of superfinished spherical surfaces.** Klingsporn, P.E. (Bendix Corp., Kansas City, MO (USA)). 1980. Contract EY-76-C-04-0613. 9p. (CONF-800506—1). Dep. NTIS, PC A02/MF A01.

From 8. North American manufacturing research conference; Rolla, MO, USA (18 May 1980).

Lapping and polishing techniques are used at Bendix Kansas City to fabricate superfinished spherical metal surfaces. A laser-light reflection method has been developed for semiautomated inspection of the surfaces. The reflected and diffracted light intensity distributions from the spherical surface are measured with an array of photodetectors interfaced with a data sampler and a minicomputer programmed to distinguish between pits and scratches. For automated measurement, standard deviations for scratch width and depth are 3 and 0.3 μm (120 and 12 μin.), respectively, and for pit diameter and depth are 5.8 and 0.9 μm (230 and 36 μin.), respectively. A laser interferometric displacement measuring system interfaced with the computer is used for automated measurement of surface waviness.

24509 (DOE/ER/10471—1) **Study of the interactions between friction, wear and system rigidity. Progress report, July 1, 1979-June 30, 1980.** Aronov, V.; D'Souza, A.F.; Kalpakjian, S.; Shareef, I. (Illinois Inst. of Tech., Chicago (USA)). Mar 1980. Contract AC02-79ER10471. 52p. NTIS, PC A04/MF A01.

Progress in friction and wear studies is reported. After an extensive study of various possible systems for friction, wear and vibration measurements, a pin and disk sliding system has been designed to be used on a rigid lathe bed. This versatile design has the capability of controlling the applied load, rigidity and damping of the total frictional system. The design and construction of the pin holding assembly has been completed with certain features to render it suitable for acquisition of appropriate data such as forces and displacements. Special instrumentation has been obtained the major components of which are a tri-axial quartz piezoelectric force transducer, a tri-axial ceramic piezoelectric accelerometer for measurements of vibrations of the slider, charge preamplifiers with dc power supply, and monitoring equipment such as a spectral analyzer and an oscillograph. Preliminary experiments indicate that the system, as designed and constructed, is appropriate for the type of study undertaken in this project. Some preliminary experimental results are included here. The method of describing functions and harmonic balance is being employed for the study of friction induced self-excited vibrations. Some new developments of this method have been obtained to take into account the coupling between the degrees of freedom in the normal and frictional directions.

24510 (DOE/ET/12438—T1) **European contribution to heat exchanger design/performance: HTFS research and computer programs. Final report.** Lang, C.; Skrovanek, T. (ENSCI, Inc., College Park, MD (USA)). 1979. Contract ET-78-C-03-1866. 106p. NTIS, PC A06/MF A01.

The performance of selected HTFS computer program in solving example heat exchanger design/performance situations is evaluated. In addition, the specific inputs required by the program are presented to give an idea of the amount of detail the user must supply concerning the heat transfer system. Comments on the versatility of each program and technical details necessary for running each program are also provided. The computer programs examined rate the performance of shell-and-tube type condensers and plate-fin heat exchangers.

24511 (DOE/TIC—11192) **Ceramic heat pipe development. Quarterly report, January 1-March 31, 1980.** Merrigan, M. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 14p. NTIS, PC A02/MF A01.

Progress in the development of ceramic heat pipes for use in high-temperature heat exchangers for recovering heat from industrial furnaces, particularly furnaces in the steel, aluminum and glass industry, is discussed. (LC)

24512 (TAC-HP—79-003) **Heat pipe technology: a bibliography with abstracts. Quarterly update July-September 1979.** (New Mexico Univ., Albuquerque (USA). Technology Application Center). Feb 1980. 94p. University of New Mexico, Albuquerque.

The third quarterly update for 1979 in the Heat Pipe Technology Bibliographic Series is presented. The coverage includes the following bibliographic material: general information, reviews, and surveys; heat pipe applications (general application, energy conversion and power, energy conservation, solar energy systems, nuclear and other energy systems, aerospace applications, and electrical); heat pipe theory (general theory, heat transfer, fluid flow); design, development, and fabrication (general, wicks, materials); and testing and operation.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 23786, 24224, 24395, 24578, 25047

24513 (CONF-791102—169) **Paramagnetic properties of mixed-matrix NbTi conductors.** Shen, S.S. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 4p. Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

Magnetization measurements are performed up to 4T on a series of samples with different compositions of Cu, CuNi, and superconductors. It is observed that most samples exhibit a strong paramagnetic moment that is in contrast with the inherent hysteretic magnetization associated with superconducting filaments. Chemical analysis results of nickel contents and iron impurities are also reported and correlated with the measured paramagnetic properties. For samples with high contents of nickel (Cu-30% Ni) and iron impurities (≧ 500 ppM), the saturated paramagnetic magnetization field can be as high as 0.02T.

24514 **Application of low-temperature scanning electron microscopy to superconductors.** Clem, J.R.; Huebener, R.P. (Ames Laboratory-USDOE and Department of Physics, Iowa State University, Ames, Iowa 50011). W-7405-ENG-82;W-7405-ENG-82. *J. Appl. Phys.;* **51**: No. 5, 2764-2773(May 1980).

Scanning electron microscopy applied to specimens in close thermal contact with a liquid-helium bath can be used for a two-dimensional display of various sample responses arising from the localized excitation of the sample by the electron beam. As shown in recent experiments, the method becomes particularly interesting when applied to superconductors. A general response theory is outlined, and a detailed treatment is given for the special case of the thermal response associated with a strongly temperature-dependent electrical resistance of the sample.

24515 **Development of A-15 (V_3Ga) superconducting material through controlled precipitation.** Hong, M.; Dietderich, D.; Morris, J.W. Jr. (Department of Materials Science and Mineral Engineering and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). W-7405-ENG-48. *J. Appl. Phys.;* **51**: No. 5, 2774-2779(May 1980).

A monolithic process has been used to produce superconducting materials by controlled precipitation of the A-15 (V_3Ga) phase inside the bcc matrix of a V-rich solid solution. Ingots of V-(17∼19 at.%)Ga were prepared by arc melting, homogenization, and quenching, were deformed at intermediate temperature into tape, and were aged at temperatures in the range 600—1000 °C to precipitate the A-15 phase. The maximum critical transition temperature (∼14.8 °K) was found in materials aged at temperatures of 750 °C or below. At these aging temperatures the T/sub c/ initially increases with aging time, and passes through a distinct maximum. The source of the exceptionally high T/sub c/ is not clear, but may be attributable to a combination of high solute content and internal strain in the small A-15 precipitate particles.

24516 **All-Nb low-noise dc SQUID with 1-μm tunnel junctions.** Voss, R.F.; Laibowitz, R.B.; Raider, S.I.; Clarke, J. (IBM Thomas J. Watson Research Center, Yorktown Heights, New York 10598). *J. Appl. Phys.;* **51**: No. 4, 2306-2309(Apr 1980).

Tunnel-junction dc SQUIDs are being fabricated from Nb films using electron-beam lithography to define linewidths as small as 0.5 μm. The barriers in the Nb-NbO/sub x/-Nb junctions are grown in an oxygen plasma discharge, and the Pd_2Si resistive shunts are formed by annealing Pd on the Si substrates. These devices have excellent storage and recycling properties. At a measurement frequency of 40 kHz, a SQUID with an inductance of about 1 nH, a critical current of about 4 μA, and a parallel shunt resistance of about 15 Ω had an intrinsic energy resolution of 2.5×10^{-32} J Hz^{-1} at 4.2 K and 1.1×10^{-32} J Hz^{-1} at 1.6 K, in good agreement with a model of the dc SQUID.

PROTECTIVE STRUCTURES AND EQUIPMENT

24517 (UCRL—84327) **Need for a contamination control textbook.** Stowers, I.F.; Patton, H.G.; Guntrum, S.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-48. 43p. (CONF-800517—5). NTIS, PC A03/MF A01.

From 26. annual technical meeting of the Institute for Environmental Sciences; Philadelphia, PA, USA (11 May 1980).

Since the authors have become associated with contamination control technology they have repeatedly found themselves searching for technical information that was either never documented and therefore never reached a technical journal or was too specific to appear in a technical article. On countless occasions they have found other workers frustrated over the same lack of concise and up to date information in the relatively broad and interdisciplinary field of

surface science, surface cleaning, and clean room operation and design. It is for these reasons that the authors wish to suggest formally that those engineers, chemists, technicians, and surface scientists working in this field collectively create a textbook that they may use as their first reference and teaching book. The text of this paper suggests a topical outline for a book and gives examples of the kinds of information that it should contain and the types of questions it should address. Included is an extensive bibliography recently collected showing the diversity of disciplines that those working in contamination control must be knowledgeable of and the variety of publications and journals in which these reports and articles are generally found.

HANDLING EQUIPMENT AND PROCEDURES

REFER ALSO TO CITATION(S) 23750

SHIPPING CONTAINERS

24518 (K/P—6567) **Cylinder overpack phenolic foam shock testing.** Strunk, W.D. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 28 Apr 1980. Contract W-7405-ENG-26. 15p. NTIS, PC A02/MF A01.

The mechanical shock absorbability of phenolic foam made from reagent grade chemicals, specified in US Atomic Energy Commission (Department of Energy) Material and Equipment Specification SP-9 is compared to that of foam made from substituted commercial grade chemicals. The testing reported herein compares mechanical properties of the foams. The test results demonstrate the equivalence in the shock absorbability of the two foam types.

24519 (SAND—79-1424) **Postmortem metallurgical examination of a fire-exposed spent fuel shipping cask.** Rack, H.J.; Yoshimura, H.R. (Sandia Labs., Albuquerque, NM (USA)). Apr 1980. Contract EY-76-C-04-0789. 35p. NTIS, PC A03/MF A01.

A potmortem examination of a large fire-exposed rail-transported spent fuel shipping container has revealed the presence of two macrofissures in the outer cask shell. The first, a part-thru crack located within the seam weld fusion zone of the outer cask shell, was typical of hot cracks that may be found in stainless steel weldments. The second, located within the stainless steel base metal, apparently originated at microcracks formed during the welding of a copper-stainless steel dissimilar metal joint. The latter microcrack then propagated during the fire-test, ultimately penetrating the outer shall of the cask. 18 figures, 2 tables.

MINING AND DRILLING EQUIPMENT AND FACILITIES

24520 (PB—299946) **Control technology for diesel equipment in the underground mining environment - a review of selected topics. Final report 23 August 1978-31 January 1979.** Wood, C.D.; Colburn, J.W. Jr. (Southwest Research Inst., San Antonio, TX (USA)). 31 Jan 1979. Contract P3381399. 64p. NTIS, PC A04/MF A01.

In reviewing the control of emission from diesel engine powered equipment used in underground mining, the following fields of interest were explored: hydrogen as fuel; lubricating oil as a source of particulates; applicability of stationary source scrubbers; worldwide diesel exhaust scrubbers; instrumentation technology for measurement of NO_2; control of emission through application of sensors and microprocessors; use of fuel additives; technology transfer of marine diesel practice; technology required to use four-stroke, aftercooled, turbocharged, direct injection engines; and oxidation and reduction catalysts for diesel engine exhausts. Recommendations for research and a bibliography and lists of references are included.

LASERS

24521 (DOE/DP/40001—1) **Krypton fluoride laser mirror study. Final report, October 1978-November 1979.** Flint, B.K.; Najmi, A.; Stelmack, L.A. (Acton Research Corp., MA (USA)). Dec 1979. Contract AC08-78DP40001. 33p. Dep. NTIS, PC A03/MF A01.

Rare gas halide lasers at 193 and 248/nm will require lower-loss optics if mirrors ad windows are not to be limiting factors in advanced DOE applications in laser fusion and photochemistry. This project addresses this problem in a number of ways, including materials investigations, test coatings, and fabrication of new uv laser coating designs, as described in more detail in the previous quarterly reports. Described in the final report are the process of making uv laser mirrors and the experimental strategy for attempting to improve them. Materials research is essential, and included selection and deposition of several condidate materials and an approximate ranking of their optical properties, so that new material combinations could be chosen, computer simulated, and deposited using improved vacuum techniques. Analysis of the electric fields within a laser mirror were employed to lower coating loss. A summary of test data is included, along with remarks on the survivability of uv laser optics, and possible future areas of inquiry, if truly low-loss uv laser mirrors are to ever be developed.

24522 (DOE/DP/40100—1) **Applied quantum chemistry advanced laser development. Final progress report, 1 October 1978-30 September 1979.** Krauss, M.; Stevens, W.J.; Julienne, P.S.; Mies, F.H. (National Bureau of Standards, Washington, DC (USA)). Nov 1979. Contract AI08-79DP40100. 30p. NTIS, PC A03/MF A01.

The included summaries are divided into three categories. First, the theoretical analyses of Raman processes in intense fields are described. Second, the electronic structure calculations are presented with a brief description of pseudopotential code development. Third, the analysis of absorption processes, both collision-induced and photoionization, and energy transfer processes is presented.

24523 (NTIS/PS—79/1067) **Carbon dioxide lasers. Volume 3. 1976-1977 (a bibliography with abstracts). Report for 1976-77.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Oct 1979. 178p. NTIS PC N01/MF N01.

This bibliography contains citations on theory, design, operation, output and diagnostics of COZ lasers. The studies relate to excitation, frequency conversion, modulation, laser pumping, reaction kinetics, gas dynamics, and plasmas. Also included are the development and efficiency of optical components; such as mirrors, resonators, tuning devices, infrared optical materials, amplifiers, and gratings. (This updated bibliography contains 171 abstracts, none of which are new entries to the previous edition.)

24524 **Optical extraction characteristics of homogeneously broadened cw lasers with nonsaturating lasers.** Eimerl, D. (Lawrence Livermore Laboratory, P.O. Box 5508, Livermore, California 94550). W-7405-ENG-48. *J. Appl. Phys.;* **51**: No. 6, 3008-3016(Jun 1980).

The optical extraction characteristics of homogeneously broadened cw lasers with nonsaturating losses are calculated exactly and compared with previous analytic approximations. The extraction efficiency as a function of the output coupling is discussed in detail for medium parameters appropriate to high-gain rare-gas-halide lasers. It is found that contrary to expectations, the output is comparatively insensitive to the medium parameters and output coupling, and that it is a poor diagnostic tool for laser medium characterization.

24525 **Two-stage pumping of three-level Moessbauer gamma-ray lasers.** Baldwin, G.C.; Solem, J.C. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). W-7405-ENG-36. *J. Appl. Phys.;* **51**: No. 5, 2372-2380(May 1980).

The possibility of creating population inversions in multiline Moessbauer nuclei by a two-stage process, employing neutron capture to generate resonance radiation that then excites states in a separate region, is investigated. Geometrical and kinetic factors and dependences of the interstage coupling on isomer ratios and Moessbauer parameters are determined. Rate equations for one hypothetical and four actual Moessbauer isotopes are solved in an approximation that overestimates the excitation; nevertheless, it is found that the necessary neutron capture rates are thermodynamically unattainable.

24526 **Multipass amplifier: Theory and numerical analysis.** Lowdermilk, W.H.; Murray, J.E. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). W-7405-ENG-48. *J. Appl. Phys.;* **51**: No. 5, 2436-2444(May 1980).

Theoretical and numerical analysis of the multipass amplifier illustrates its flexibility in applications ranging from efficient high-power pulse amplification to short-pulse generation with great amplitude and pulse-width stability.

24527 **Determination of spatial energy deposition in e-beam-pumped laser cells by pressure measurements.** Eckstrom, D.J.; Walker, H.C. Jr. (Molecular Physics Laboratory, SRI International, Menlo Park, California 94025). ES-78-C-05-5606. *J. Appl. Phys.;* **51**: No. 5, 2458-2463(May 1980).

A significant fraction of the energy deposited by electron beams in gases results in heating of the gas, which causes a transient pressure rise in the cell. When the pressure rise is uniform across the height and length of the cell, but varies across the depth, one-dimensional unsteady flow theory applies. Then a fast-response pressure measurement at the back wall of the cell can be interpreted to give the initial spatial pressure distribution. We describe the relationship between time and space coordinates for both low and medium levels of excitation in the cell. Experiments are discussed which illustrate the application of this technique. Analytical predictions using the SANDYL 3-D electron scattering code show basic agreement with the experimental results, but indicate some areas for improvements in the calculations. Intermediate-response pressure measurements are shown to be inadequate to determine the local deposition when the deposition varies markedly across the cell.

24528 Conditions for soft x-ray lasing action in a confined plasma column. Suckewer, S.; Fishman, H. (Princeton University, Plasma Physics Laboratory, Princeton, New Jersey 08544). EY-76-C-02-3073. *J. Appl. Phys.;* **51**: No. 4, 1922-1931(Apr 1980).

The idea of using a multi-Z (e.g., carbon, oxygen) thin plasma column as a medium for soft x-ray lasing action is presented. A plasma confined by a strong magnetic field is first heated by a CO_2 laser, and then cools rapidly by radiation losses. This leads to a level population inversion of hydrogen-like carbon or oxygen ions. Two computational models are presented. One uses given electron temperature T/sub e/(t) evolutions. The other uses T/sub e/(t) calculated from an energy balance equation with CO_2 laser beam power as a parameter. According to calculations, a total gain of $G>100$ is expected for $3\rightarrow2$ and $G>10$ for $4\rightarrow2$ transitions ($\lambda=182$ A and $\lambda=135$ A, respectively) for C VI ions using a CO_2 laser beam with power $\sim5 \times 10^{10}$ W for plasma column heating.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 24510, 24512, 24974

24529 (PB—299905) **Two-phase vapour-liquid flow with phase change, review.** Ellman, M.J. (Council for Scientific and Industrial Research, Pretoria (South Africa). Chemical Engineering Research Group). Jul 1979. 94p. NTIS, PC A05/MF A01.

Existing theories for regimes of boiling, condensation or two-phase vapour-liquid flow consider only one of these aspects at a time. In addition, transitions between regimes are predicted by empirical relationships which often do not tie in with the separate theories covering the regimes on either side of the transition. Available two-phase flow models predict only overall combined flow behaviour since those that attempt to account for phase interactions are incomplete due to lack of knowldge about the required constitutive equations. The data bases used to derive various correlations are often unreliable due to inaccuracies in measurement and incomplete documentation on experimental conditions; they are usually biased in favour of steam-water, air-water and air-oil systems. Measurement techniques on boiling, condensation and two-phase vapour-liquid flow have been inadequate. As a result of all these shortcomings the relevant equipment design has been inaccurate (large safety factors being applied) which has impaired efficiency and operational safety. It is recommended that a comprehensive and integrated theory of two-phase flow with boiling be developed and mathematical models derived which account for phase interactions and which cover the full range of flow regimes. Also, that the parameters involved be evaluated only with the aid of reliable well-documented sets of data and that improved measurement techniques be developed for this field so that reliable data sets can be obtained.

24530 Investigations of sparging as a method for promoting cooling pond heat transfer. Hicks, B.B. (Atmospheric Physics Section, Radiological and Environmental Research Division, Argonne National Laboratory, Argonne, IL 60439). *J. Appl. Meteorol.;* **19**: No. 2, 193-198(Feb 1980).

Destruction of the thin subsurface thermal boundary layer at an air-water interface can be accomplished by relatively low rates of aeration and can result in substantially improved thermal performance when water temperatures are high. The heating and saturating of rising air bubbles can also provide a significant improvement in overall thermal performance when water temperatures and aeration rates are sufficiently great. At 80 °C, improvements of ~20% appear possible with average aeration rates <1 mm s^{-1}.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 24392, 24417, 24446, 24507, 24566, 24567, 25105

24531 (EPRI-EL—1263, pp 6.1-6.10) **Use of x-ray fluorescence spectral analysis in material characterization for quality control.** Gosselin, L.J. (IBM Corp., Endicott, NY). Nov 1979.

From Conference on electrical insulation and dielectric phenomena; Schenectady, NY, USA (17 Oct 1977).

X-ray fluorescence spectrography for use in the spectral analysis in material characterization for quality control is described. Spectra of phosphorus based flame retardant in a thermoplastic compound, molybdenum disulfide in nylon, and coaxial cable sheathings are given.

24532 Photoelastic studies of three-dimensional stress field caused by a cylindrical punch. Chu, S.N.G.; Li, J.C.M. (Materials Science Program, Department of Mechanical and Aerospace Sciences, University of Rochester, Rochester, New York 14627). EY-76-S-02-2296001. *J. Appl. Phys.;* **51**: No. 6, 3338-3342(Jun 1980).

A stress-freezing technique is used to observe the stress distribution inside a cylindrical body produced by a coaxially loaded cylindrical punch. The flat end of the punch is pressed against the top surface of a vertical cylinder. After the stress is frozen in, a thin vertical diametric slice is prepared for photoelastic observation. The stress distribution is compared with theoretical results calculated for a semi-infinite body using the following two boundary conditions: uniform displacement of the punch and uniform pressure under the punch. The agreement is good at long distances (three times the punch radius) with either boundary condition. At short distances, the observed stress distribution is in between but close to the uniform displacement boundary condition. These results support the use of mixed stress distributions under the punch in a previous finite-element calculation of impressing creep velocities.

SAFETY ENGINEERING

24533 Pressure vessel safety: the story of the ASME code. Canonico, D. *Oak Ridge Natl. Lab. Rev.;* **12**: No. 4, 30-34(Fal 1979).

This article outlines the development of the American Society for Mechanical Engineers (ASME) code used by manufacturers and users of pressure vessels. The early history of pressure-vessel use was marked by numerous catastrophic explosions. While pressure vessel failures are not infrequent - and catastrophic failures, rare - credit for their reliable service can be attributed, according to the article, to the development and use of codes and standards in our country and abroad. In 1911 the ASME formed a committee to formulate standard specifications for the construction of steam boilers and other pressure vessels and for their care in service. Since the earliest 3-page code was issued, the ASME code has grown to volumes. The special nature of nuclear-reactor pressure vessels is highlighted by the article. (SAC)

VACUUM ENGINEERING

24534 Development of bakeable seals for large noncircular ports on the Tokamak Fusion Test Reactor. Fleming, R.B.; Brocker, R.W.; Mullaney, D.H.; Knapp, C.A. (Princeton Plasma Physics Laboratory, Princeton, New Jersey 08544). EY-76-C=02-3073. *J. Vac. Sci. Technol.;* **17**: No. 1, 337-341(Jan 1980).

The Tokamak Fusion Test Reactor (TFTR), being constructed at the Princeton Plasma Physics Laboratory, has a total of 60 large ports of rectangular and racetrack shape that must be equipped with demountable seals. The largest port is a rectangle about 0.74 x 0.89 m. Seals must be compatible with a 10^{-8} Torr base pressure, be bakeable to 250°C, and be capable of remote demounting and resealing. A literature search and initial experiments showed that conventional commercially available sealing approaches were not useful, partly because of the large sizes and the noncircular shapes. Successful tests were made with "Helicoflex" seals. These seals consisted of a helical Inconel wire, surrounded by a stainless steel jacket that is covered with a soft metal, and were compressed between flat flange surfaces. General results were: a silver covering performed better than aluminum; with a smooth flange surface, higher compression produced better results; and performance was improved by striations produced in flange surfaces along the direction of the seal axis.

24535 Ultrahigh vacuum system for ISABELLE full cell. Skelton, R.; Briggs, J.; Chou, T.S.; Foerster, C.; Stattel, P. (Brookhaven National Laboratory, Upton, New York, 11973). *J. Vac. Sci. Technol.;* **17**: No. 1, 342-344(Jan 1980).

A vacuum system consisting of a 40 m long 8.8-cm-diam stainless steel tube, pumped by seven pumping stations, has been assembled using automatic welding methods. All components have been fired at 950°C in a vacuum furnace at a pressure $<1 \times 10^{-4}$Torr. Each pumping station contains a Ti-sublimator, a 20 l/s ion pump and a UHV gauge. After assembly, the entire system was baked out at 250°C for 24 h. A pressure $<1 \times 10^{-11}$Torr was reached after titanium flash. In this paper we will discuss: (a) surface treatment of stainless for 10^{-11} Torr operation, (b) bake out and conditioning cycle to read 1×10^{-11} Torr, and (c) leak checking at low pressures.

24536 Self-modulating ion gauge. Edwards, D. Jr.; Lanni, C. (Brookhaven National Labortory, Upton, New York 12101). *J. Vac. Sci. Technol.;* **17**: No. 1, 355-356(Jan 1980).

A Bayard—Alpert ionization pressure gauge has been modified by shortening the collector wire thereby reducing the x-ray limit from $\sim2.5 \times 10^{-11}$ to $\sim0.6 \times 10^{-11}$ Torr. In addition it has proven possible to modulate this gauge and thus make an in situ determination of the x-ray limit without the introduction of a modulation electrode. Thus a self-modulating, low x-ray limit ion gauge has been developed at reasonably low cost and seems particularly suited to the ISABELLE ultrahigh vacuum system.

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 24993, 25053, 25055, 25061

24537 (GEPP-FR—434) **Quartz crystal fabrication facility. Phase I. Final report, April 1977-September 1979.** Ney, R.J. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). May 1980. Contract AC04-76DP00656. 66p. NTIS, PC A04/MF A01.

The design and operation of a five chamber, interconnected vacuum system, which is capable of cleaning, plating, and sealing precision quartz crystal units in ceramic flatpack enclosures continuously in a high vacuum environment are described. The production rate design goal was 200 units per eight hour day. A unique nozzle beam gold deposition source was developed to operate for extended periods of time without reloading. Entrance and exit air lock chambers expedite the material throughput, so that the processing chambers are at high vacuum for extended periods of time. A stainless steel conveyor belt, in conjunction with three vacuum manipulators, transport the resonator components to the various work stations. The system utilizes molybdenum disulfide coated ball bearings at essentially all friction surfaces. The conveyors are capable of operating at 300°C temperature and 10^{-8} Torr. Meta bellows or magnetic drives are utilized to transfer motion into the vacuum chambers. The gold sources and plating mask heads are equipped with elevators and gate valves, so that they can be removed from the system for maintenance without exposing the chambers to atmosphere. The work stations include: ultraviolet/ozone cleaning, 300°C vacuum baking, coarse and fine gold deposition stations with automatic frequency plating controls, and a gold thermocompression sealing station. The length of the combined vacuum envelope is 24 ft.

24538 (UCID—18626) **Computer modeling of antennas near the ground.** Burke, G.J.; Brittingham, J.N.; Lager, D.L.; Lytle, R.J.; Miller, E.K.; Okada, J.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 May 1980. Contract W-7405-ENG-48. 55p. NTIS, PC A04/MF A01.

An accurate and efficient numerical method based on the rigorous Sommerfeld theory is described for modeling antennas near an interface such as the ground. The Sommerfeld integrals are evaluated by numerical integration along contours in the complex plane and two-dimensional interpolation is used subsequently to obtain the many Sommerfeld integral values needed for the moment-method solution of an integral equation. These methods permit modeling an antenna within 10^{-6} wavelengths of the ground for about two to four times the computation time for the same antenna in free space. Results showing currents and radiation patterns are included.

24539 Evidence of tunnel-assisted transport in nondegenerate MOS and semiconductor-oxide-semiconductor diodes at room temperature. Kar, S.; Ashok, S.; Fonash, S.J. (Department of Engineering Science and Mechanics, The Pennsylvania State University, University Park, Pennsylvania 16802). 34-JP-20471-A. *J. Appl. Phys.;* **51**: No. 6, 3417-3421(Jun 1980).

Metal-oxide-semiconductor diodes have been fabricated on p-type Wacker polycrystalline silicon with aluminum barrier metal, and semiconductor-oxide-semiconductor diodes have been fabricated by chemical spraying of indium-tin oxide on n-type single-crystal silicon. The current-voltage and capacitance-voltage characteristics of these diodes have been measured at various values of temperature above 300 K and analyzed. The results indicate the likelihood of the primary transport mechanism's being multistep tunneling instead of thermionic emission or minority carrier injection. The study also stresses the importance of investigating the temperature dependence of electrical characteristics before any firm conclusions may be drawn about the conduction mechanisms in semiconductor junctions.

24540 Video recording of low intensity CEMA images. Panitz, J.A. (Sandia Laboratories, Albuquerque, New Mexico 87185). DE-AC04-76-DP00789. *J. Vac. Sci. Technol.;* **17**: No. 3, 757-758(May 1980).

An assembly of TV components used to observe, record, and display low-light-level visual images is described. The system has been used to analyze static field-ion and transient field-desorption images from a CEMA detector operating in ultrahigh vacuum. (AIP)

24541 Detection of perpendicular line intersections. Lahart, M.J. (University of California, Los Alamos Scientific Laboratory, P.O. Box 1663, Los Alamos, New Mexico 87545). *Appl. Opt.;* **19**: No. 7, 1033-1034(1 Apr 1980).

An automatic pattern recognition system is described which employs a digital approximation of a ring.

24542 Hot carrier injection at semiconductor-electrolyte junctions. Boudreaux, D.S.; Williams, F.; Nozik, A.J. (Corporate Research Center, Allied Chemical Corporation, Morristown, New Jersey 07960). EG-77-C-01-4042. *J. Appl. Phys.;* **51**: No. 4, 2158-2163(Apr 1980).

It is shown that the energy of electronic minority charge carriers injected into an electrolyte from an illuminated semiconductor electrode may be significantly greater than that predicted by previous models. The time constants for tunneling from the semiconductor states in the depletion region are evaluated by two methods: approximating the final states as a continuum resulting from strong electron-vibration interaction in the electrolyte, and calculating the oscillation time between semiconductor states and the discrete electrolyte states before vibrational relaxation. Comparisons are made with the time constants for intraband electronic relaxation in the semiconductor, including the effects of quantization due to confinement in the depletion region, and with those for the vibrational relaxation in the electrolyte. The general conditions for the injection of hot carriers from semiconductors into electrolytes are specified.

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 23459, 23559, 23560, 23561, 24293

24543 (SAI—129-79-PGH) **Reliability analysis of the Georgetown University Atmospheric Fluidized Bed Combustor. Final report.** Hammelman, J.E.; Land, R.E.; Simmons, J.A.; Wood, P.J. (Science Applications, Inc., McLean, VA (USA)). 30 Nov 1979. Contract EW-78-C-21-8333. 208p. Dep. NTIS, PC A10/MF A01.

A preliminary predictive reliability analysis for the Georgetown University Atmospheric Fluidized Bed Combustor was performed using a Failure Modes and Effects Analysis (FMEA) technique. The analysis identified the plant areas expected to be more troublesome during the operational stages. Recommendations are made for spare parts, operating procedures and future data collection and reporting activities.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 24787

MARINE ENGINEERING

REFER ALSO TO CITATION(S) 23868

POLLUTION CONTROL EQUIPMENT

REFER ALSO TO CITATION(S) 24595

24544 (NTIS/PS—79/1035) **Electrostatic precipitators. Volume 2. 1975-1977 (citations from the Engineering Index Data base). Report for 1975-77.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Oct 1979. 244p. NTIS PC N01/MF N01.

Research from the worldwide journal literature on electrostatic precipitators for air pollution control is cited in this bibliography. The citations cover the design, performance, theory, installation methods, and principal applications. (This updated bibliography contains 238 abstracts, none of which are new entries to the previous edition.)

24545 (NTIS/PS—79/1056) **Nitrogen oxide air pollution. Part 1. Control technology. volume 2. 1975-1977 (a bibliography with abstracts). Report for 1975-77.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Oct 1979. 224p. NTIS PC N01/MF N01.

This bibliography cites studies on nitrogen oxide air pollution control from both mobile and stationary sources. Topics include fluidized bed combustion, boiler combustion modification, and engine design related to emission reduction. (This updated bibliography contains 217 abstracts, none of which are new entries to the previous edition.)

24546 (NTIS/PS—79/1057) **Nitrogen oxide air pollution. Part 1. Control technology. Volume 3, 1978-August, 1979 (a bibliography with abstracts). Report for 1978-August 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Oct 1979. 189p. NTIS PC N01/MF N01.

Nitrogen oxide air pollution control is considered from both mobile and stationary sources. Fluidized bed combustion, boiler combustion modification, and engine design are discussed, as they relate to emissions reduction. (This updated bibliography contains 182 abstracts, 100 of which are new entries to the previous edition.)

24547 (PB—300469) **Environmental assessment of stationary source NOx control technologies. Annual report no. 2, June 1977-June 1978.** Waterland, L.R.; Lim, K.J.; Salvesen, K.G.; Evans, R.M.; Higginbotham, E.G. (Acurex Corp., Mountain View, CA (USA). Aerotherm Div.). Jun 1979. Contract EPA-68-02-2160. 201p. NTIS, PC A10/MF A01.

The report summarizes results of the 2nd year of an environmental assessment of stationary source NOx control technologies. The 2nd year effort focused on: (a) characterizing the baseline (uncontrolled) environmental impact of stationary combustion sources; (b) developing fuel consumption and NOx emission inventories and projecting these to the year 2000; (c) field testing selected stationary combustion sources to determine multimedia pollutant emissions under both baseline and controlled (for NOx) operation; (d) performing process engineering and environmental assessment studies of NOx controls applied to utility and industrial boilers and to gas turbines; (e) assembling and exercising reactive air quality models in systems analysis applications; and (f) developing source analysis models for environmental impact evaluation. The report summarizes program results in each of these areas. Preliminary NOx control technology analysis for utility boilers indicates that off-stoichiometric combustion and low NOx burners (LNB) are the preferred techniques for both retrofit and new applications. For coal firing, overfire air operation and LNB are both cost effective; LNB is preferred for new wall-fired boilers. For oil and gas firing, staged combustion with burners out of service is recommended.

POWER CYCLES

REFER ALSO TO CITATION(S) 24309

STIRLING

REFER ALSO TO CITATION(S) 24010

PARTICLE ACCELERATORS

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

24548 **Longitudinal instabilities of pulseline driven neutralized linear ion accelerators.** Humphries, S. Jr. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* **51**: No. 5, 2338-2347(May 1980).

Linear accelerators driven by pulse forming networks and utilizing beam neutralization may be useful for obtaining high-current ion beams for inertial fusion applications. Such accelerators may be subject to longitudinal velocity bunching instabilities. These instabilities are studied with a computer simulation of longitudinal ion dynamics. It is found that they are stabilized by a velocity spread in the beam distribution determined by the properties of the pulse-lines. The required velocity spread does not preclude obtaining beams of sufficient quality for fusion applications.

24549 (UCRL-Trans—1592) **Experiments on high-current proton beams at Novosibirsk.** Bel'chenko, Yu.I.; Budker G.I.; Derevyankin, G.E.; Dimov, G.I.; Dudnikov, V.G.; Roslyakov, G.V.; Chupriyanov, V.E.; Shamovskii, V.G. (AN SSSR, Novosibirsk. Inst. Yadernoj Fiziki). 1980. Translated from 10th international conference on high energy accelerators, Serpukhov, USSR, 1977. 18p. NTIS, PC A02/MF A01.

The present paper gives the results of the latest experiments, in which it was possible to obtain a compensated proton beam with a current considerably exceeding the space charge limit. The experiments were performed with the acceleration ring with an H^- ion injector using a current of 20 mA at an energy of 1 MeV. The period of revolution of the protons around the orbit was 0.54 μs, and the limiting number of protons based on the space charge was $1.9 \cdot 10^{11}$ (by shifting the frequency ν/sub z/ from 0.85 to 0.5). The absolute space charge limit was $2.9 \cdot 10^{11}$ protons.

AUXILIARIES AND COMPONENTS

ION SOURCES

24550 **Production and postacceleration of intense ion beams in magnetically insulated gaps.** Humphries, S. Jr.; Freeman, J.R.; Greenly, J.; Kuswa, G.W.; Mendel, C.W.; Poukey, J.W.; Woodall, D.M. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* **51**: No. 4, 1876-1895(Apr 1980).

Experiments are described pertaining to the development of very high-current pulsed linear ion accelerators utilizing electron neutralization. A novel magnetically insulated gap using radial magnetic fields has been tested. It provides stable electron cloud confinement over microsecond time scales with no detectable leakage current. The gap can act as an ion injector when used in conjunction with a plasma source. Control of the electron cloud dynamics allows the injector to operate in an enhanced current density mode (10—50 times the Child-Langmuir limit) with high efficiency and with plasma source control of the current flow. Currents up to 20 kA at 100 kV applied voltage resulted when using a light-ion flashboard plasma source. Carbon beams were produced by extraction from a flowing plasma from a gun array. A 3-kA beam with equal fractions of C^+ and C^{++} was extracted over a microsecond time scale with little proton contamination. The use of active plasma injection into the high-intensity magnetically insulated diode had the advantages of ion species control, reduction of gap damage, operation at constant impedance, elimination of plasma closure effects, and a demonstrated ability to control the extracted beam optics. Observations were also made of beam propagation and compared to fast neutralization models. Agreement was good, and an upper limit of 0.2% was calculated for the imbalance of ion and electron space charge. When using the carbon injector, two-thirds of the beam reached a second magnetically insulated gap where it was postaccelerated. The second gap had an applied voltage in the range 150 —200 kV with beam currents typically 2 kA. Observations were made of electrostatic focusing in the postacceleration gap. These were in good agreement with theory based on the concept of virtual electrodes determined by the neutralizing electron dynamics.

EXPERIMENTAL FACILITIES AND EQUIPMENT

24551 (ACC—6) **Hearthfire reference concept No. 3. A rapid cycling synchrotron system.** Arnold, R.C.; Burke, R.J.; Foss, M.H.; Khoe, T.K.; Martin, R.L. (Argonne National Lab., IL (USA)). 16 Jun 1978. Contract W-31-109-ENG-38. 32p. NTIS, PC A03/MF A01.

This report describes a reference design for an accelerator system for heavy ion fusion based on a rapid cycling synchrotron and storage rings. The system irradiates one fusion target per second with 1 MJ, 100 TW (peak) pulses of 20 GeV Xe^{+1}. The major components are a 550 MV linac, eight 60 Hz synchrotrons, four matching rings, 16 storage rings, and 24 final beam lines and lenses.

24552 (CONF-790976—10) **UNISOR facility: recent developments and future directions.** Spejewski, E.H.; Mlekodaj, R.L. (Oak Ridge Associated Universities, Inc., TN (USA)). 1979. Contract W-7405-ENG-26. 7p. Dep. NTIS, PC A02/MF A01.

From International symposium on future directions in studies of nuclei far from stability; Nashville, TN, USA (10 Sep 1979).

The UNISOR isotope separator is described. This facility is presently on line to the Oak Ridge Isochronous Cyclotron, and will also be on line to a 25-MV folded tandem accelerator when the latter is completed. Intended primarily for the study of nuclei far from stability by means of radioactive-decay spectroscopy, the facility is designed and has been expanded to do multiple experiments simultaneously. This ability makes possible the completion of many studies that can expose the systematic behavior of nuclear structures over a relatively wide mass range. Aspects of the facility discussed include the following: the isotope separator itself, ion sources, available heavy-ion beams and beam handling equipment, collection systems, and data acquisition and handling. 3 figures.

24553 (LA—8293-PR) **Medium-energy physics program. Quarterly progress report, May 1-July 31, 1979.** van Dyck, O.B.; Dunn, E.D. (comps.). (Los Alamos Scientific Lab., NM (USA)). Mar 1980. Contract W-7405-ENG-36. 68p. Dep. NTIS, PC A04/MF A01.

This report covers most of LAMPF Operating Cycle 24, with a nominal 500-μA H^+ beam, plus low-intensity H^- and polarized H^- beam. Seventy-two experiments received beam this cycle.

24554 (LA—8356-MS) **Investigation of a large solid angle pion channel for a medical application utilizing current sheets and solenoid elements.** Sugimitsu, T.; Swenson, D.A. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 18p. NTIS, PC A02/MF A01.

For the treatment of tumors with pi-minus mesons (pions), a pion channel with a large solid angle is essential. A parallel beam of uniform density and reasonable size at the patient position is favored from the practical point of view. A new pion channel with sixty toroidal current sheets and some solenoids is shown to meet these requirements. It would also be useful for some physics experiments using low-energy pion and muon beam.

24555 (LBL-PUB—300) **Research/Accelerators. Bimonthly status report of operations, November-December 1979. Volume 4, Number 6.** Knight, J.W. (ed.). (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1979. Contract W-7405-ENG-48. 60p. NTIS, PC A04/MF A01.

Topics covered include: a survey of the Heavy Ion Spectrometer System; a report on mean free paths of tertiary particles relative to those of primaries and secondaries; the heavy ion fusion year-end report; a listing of publications and presentations from LBL accelerators group during November-December 1979; a summary of accelerator operations and research programs for the Bevatron/Bevalac, super HILAC, 88-inch cyclotron and 184-inch cyclotron; and a brief report on the PEP storage ring progress. (GHT)

STORAGE RINGS

24556 (BNL—27654) **Optimization of a synchrotron radiation source.** van Steenbergen, A. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 18p. (CONF-791176—2). NTIS, PC A02/MF A01.

From Japan-USA seminar on synchrotron radiation facilities; Honolulu, HI, USA (5 Nov 1979).

Some aspects of the optimization of an electron storage ring as a synchrotron radiation source will be presented. This will include the choice of magnet ring structure, choice of electron accelerating system parameters and choice of structure sections for the use of high field wigglers or undulators.

24557 (BNL—27678) **Characteristics of synchrotron radiation and of its sources.** Krinsky, S.; Perlman, M.L.; Watson, R.E. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 206p. NTIS, PC A10/MF A01.

Synchrotron light emission and the classical relativistic electromagnetic theory describing it are reviewed. The electron optics of storage rings are considered in some detail, beginning with the ideal electron orbit and the distribution which electrons take around it. This is folded with the process of synchrotron light emission itself to define the effective photon source. The predictions of classical relativistic theory are compared with experiment, and one finds agreement within the experimental uncertainties. Further refinements, such as wiggler magnets and free electron lasers are also considered. (GHT)

24558 **Methane outgassing from a Ti sublimation pump.** Edwards, D. Jr. (Brookhaven National Laboratory, Upton, New York 11973). *J. Vac. Sci. Technol.;* **17**: No. 1, 279-281(Jan 1980).

A Ti sublimation pump together with a small 20 l/s ion pump is typically used as the pump for UHV systems. It is well known that the Ti surface will not pump methane and that the ion pump pumping speed for CH_4 is only 1 l/s in the low 10^{-11} Torr range. Thus it is important to identify and if possible reduce the sources of CH_4 outgassing. In this study we report the first quantitative measurements of the methane outgassing rate from a 1500 cm^2 Ti sublimation chamber both before and after the Ti evaporation. The contrast to the very low CH_4 outgassing rate from the chamber before the Ti is flashed ($<10^{-12}$ Torr l/s) the CH_4 outgassing rate after the Ti evaporation is considerable (4×10^{-11} Torr l/s) with a very slow decrease with repect to time, and has been found to be significant in terms of the ISABELLE requirements. To essentially eliminate the methane outgassing from the Ti getter chamber, it has been determined sufficient to heat the Ti chamber for four hours at 100 C after the Ti evaporation has been completed. Using a similar procedure a reasonably rapid processing of the ISABELLE vacuum system to an ultrahigh vacuum condition should be possible after an atmospheric exposure.

INSTRUMENTATION

RADIATION INSTRUMENTATION

24559 (CONF-791117—26) **New advanced in alpha spectrometry by liquid scintillation methods.** McDowell, W.J.; Case, G.N. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 10p. NTIS, PC A02/MF A01.

From ANS topical conference; Kiawah Island, SC, USA (26 Nov 1979).

Although the ability to count alpha particles by liquid scintillation methods has been long recognized, limited use has been made of the method because of problems of high background and alpha energy identification. In recent years some new developments in methods of introducing the alpha-emitting nuclide to the scintillator, in detector construction, and in electronics for processing the energy analog and time analog signals from the detector have allowed significant alleviation of the problems of alpha spectrometry by liquid scintillation. Energy resolutions of 200 to 300 keV full peak width at half maximum and background counts of < 0.01 counts/min with rejection with rejection of $> 99\%$ of all beta plus gamma interference is now possible. Alpha liquid scintillation spectrometry is now suitable for a wide range of applications, from the accurate quantitative determination of relatively large amounts of known nuclides in laboratory-generated samples to the detection and identification of very small, subpicocurie amounts of alpha emitters in environmental-type samples. Suitable nuclide separation procedures, sample preparation methods, and instrument configurations are available for a variety of analyses.

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 24489, 24559, 24647

24560 (CONF-790859—3) **Alpha liquid scintillation counting: past, present, and future.** McDowell, W.J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 19p. NTIS, PC A02/MF A01.

From International conference on liquid scintillation counting--recent applications and development; San Francisco, CA, USA (21 Aug 1979).

Beta liquid scintillation counting has been used for about 30 years, and its effectiveness for alpha particles has been known for almost that long; however, the technique has not been widely applied to alpha particle detection because of poor energy resolution, high background, and variable interference from beta and gamma radiation. Beginning with the work of Horrocks in the early 1960s, improvements in energy resolution and background rejection have been made. Further developments at Oak Ridge National Laboratory over the past 10 to 12 years have resulted in improved methods of sample preparation (using liquid-liquid extraction methods to isolate the sample and introduce it into the scintillator) and better instrumentation, including electronic rejection of beta and gamma pulses. Energy resolutions of 200- to 300-keV FWHM and background counts of 0.01 cpm are now routine. Alpha liquid scintillation spectrometry is now suitable for a wide range of applications, from the accurate quantitative determination of relatively large amounts of known nuclides in laboratory-generated samples to the detection and identification of very small, subpicocurie amounts of alpha emitters in environmental-type samples. Suitable nuclide separation procedures, sample preparation methods, and instrument configurations are outlined for a variety of analyses.

RADIATION DOSEMETERS

24561 (CONF-7910149—1) **Ceramic BeO exoelectron dosimeters for tritium and radon monitoring.** Gammage, R.B. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 11p. NTIS, PC A02/MF A01.

From 6. international symposium on exoelectron emission and dosimetry; Arhenshoop, German Democratic Republic (8 Oct 1979).

An environmental monitoring device with BeO ceramic dosimeters can be used to measure ^{222}Rn in dwellings. Radon diffuses into a porous hemispheric chamber and the radon daughters are electrostatically collected on aluminized Mylar foil covering the BeO dosimeter that records the alpha activity. A 10:1 signal-to-background ratio results from a radon exposure of only pCi-h/l. This high sensitivity makes accurate radon measurement possible within one day, even at near background levels of a few tenths pCi/l. The BeO exoelectron dosimeter is also uniquely suited for monitoring occupational exposure to insoluble tritium gas. At one-fifth the maximum permissible concentration, exposure for 8 hours gives a 10:1 signal-to-background exoelectron response to the low energy beta rays. Compensation for any exoelectron response caused by photon radiation can be made by reading the thermoluminescence. The tritium exposure produces negligible thermoluminescence. Progress in these and other applications is now totally dependent on achieving reliability and long-term stability of the exoelectron dosimeter.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

24562 (PB—301041) **Measurements of the performance parameters of gamma cameras: Part II. Final report.** Hine, G.J.; Paras, P.; Warr, C.; Adams, R. (Bureau of Radiological Health, Rockville, MD (USA)). Jun 1979. 64p. NTIS, PC A04/MF A01.

Methods are described for field measurements of the performance parameters of gamma cameras, also called Anger or scintillation cameras. Their system spatial resolution was measured with arrays of 57Co and 195Au line sources emitting gamma rays in the range of 70 to 140 KeV, and is of special interest to clinical nuclear medicine. The system sensitivity is determined with calibrated flood sources of the same two long-lived radionuclides. The temporal resolution is derived from counting-rate measurements with a two-source scatter phantom with 99mTc sources in test tubes. In clinical procedures the observed counting rates should be limited to incur counting losses of less than 25 percent. Data for each of the three parameters are presented for more than 50 gamma-camera models from eight manufacturers, employing their low-energy high-resolution, general purpose and high-sensitivity parallel-hole collimators.

HIGH ENERGY PHYSICS INSTRUMENTATION

24563 (NRL-MR—4171) **Absolute calibration of a prompt gamma ray detector for intense bursts of protons.** Young, F.C.; Oliphant, F.; Staphanakis, S.J.; Knudson, A.R. (Naval Research Lab., Washington, DC (USA)). 31 Mar 1980. Contract EX-76-A-34-1006. 33p. NTIS, PC A03/MF A01.

A detector for determining the itensity and duration of kiloampere pulsed proton beams is described. Proton intensities are inferred from measurements of prompt gamma rays of 6 to 7 MeV from the $^{19}F(p,\alpha\gamma)^{16}O$ reaction. The thick-target yield for this reaction on a teflon target was measured for 0.5 to 2.8 MeV protons. Two different size detectors were calibrated absolutely using the continuous proton beam from a Van de Graaff accelerator. An absolute measurement of a kiloampere pulsed proton beam is described, and the measured current is in agreement with an independent determination of the total proton intensity by nuclear activation.

24564 **New particle detector: a spark counter with localized discharge.** Laptev, V.D.; Pestov, Yu.N.; Petrovykh, N.V.; Sannikov, B.P.; Fedotovich, G.V. (Inst. of Nuclear Physics, Novosibirsk, USSR). *Izv. Akad. Nauk SSSR, Ser. Fiz.;* **42**: No. 7, 1488-1490(Jul 1978). (In Russian).

A new kind of particle detector is described - a flat spark counter with localized discharge. In contrast to conventional plane-parallel spark counters, this device makes use of a material with high resistivity (10^9 to 10^{10} Ω.cm) as one of the counter electrodes, and the interelectrode gap is filled with a gas mixture that absorbs photons from the spark. As a result, at the instant of breakdown the fixed voltage applied to the counter plates is taken off from a limited region of the electrodes near the discharge. This localization of the discharge eliminates the size limitation inherent in conventional spark counters, where increasing the size causes a rise in energy released during breakdown, resulting in electrode damage. The proposed design also increases count rate since discharge localization makes the device equivalent to a large number of independent spark counters. Analysis of experimental data shows that time resolution of a single counter is about 28 ns, assuming gaussian distribution. Accuracy of coordinate location is about 0.1 mm, which is on a level with other types of modern spark counters. The data output of the counters is convenient for on-line operation with a computer. 10 figures, 2 figures.

RADIOMETRIC INSTRUMENTS

24565 (DOE/ID/01570—T4) **Microprocessor-controlled scanning densitometer system.** Shurtliff, R.W. (EG and G Idaho, Inc., Idaho Falls (USA)). Apr 1980. Contract EY-76-C-07-1570. 30p. NTIS, PC A03/MF A01.

Thesis. Submitted to Idaho Univ., Moscow.

An Automated Scanning Densitometer System has been developed by uniting a microprocessor with a low energy x-ray densitometer system. The microprocessor controls the detector movement, provides self-calibration, compensates raw readings to provide time-linear output, controls both data storage and the host computer interface, and provides measurement output in engineering units for immediate reading. The densitometer, when used in a scanning mode, is a precision reference instrument that provides chordal average density measurements over the cross section of a pipe under steady-state flow conditions. Results have shown an improvement over the original densitometer in reliability and repeatability of the system, an a factor-of-five improvement in accuracy.

24566 (RDT-F—3-6T(ERRATA)) **Nuclear standards transmittal.** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). 14 May 1980. 9p. RSO.

The limits of required Sensitivity shall be established by placing one penetrameter of the required thickness at each end of a weld in a test radiograph. The maximum spacing between penetrameters during production radiography shall not exceed the spacing between the two penetrameters in a test radiograph that meets the requirements.

24567 (RDT-F—3-6T-(4-80)(Amendt)) **Nuclear standards transmittal.** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). 14 May 1980. 11p. NTIS, PC A02/MF A01.

The limits of required sensitivity shall be established by placing one penetrameter of the required thickness at each end of a weld in a test radiograph. The maximum spacing between penetrameters during production radiography shall not exceed the spacing between the two penetrameters in a test radiograph that meets requirements.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 23455, 23560, 24417, 24540, 24586, 24701

24568 **High-temperature, high-pressure bonding of nested tubular metallic components.** Quinby, T.C. US Patent Application 002,140. [nd]. 9p.

A tool is described for effecting high-temperature, high-compression bonding between the confronting faces of nested, tubular, metallic components. In a typical application, the tool is used to produce tubular target assemblies for irradiation in nuclear reactors or particle accelerators. The target assembly comprising a uranum foil and an aluninum-alloy substrate. The tool is composed of graphite. It comprises a tubular restraining member in which a mechanically expandable tubular core is mounted to form an annulus. The components to be bonded are mounted in nested relation in the annulus. The expandable core is formed of individually movable, axially elongated segments whose outer faces cooperatively define a cylindrical pressing surface and whose inner faces cooperatively define two opposed, inwardly tapered, axial bores. Tapered rams extend into the bores. The loaded tool is mounted in a conventional hot-press provided with evacuation means, heaters for maintaining its interior at bonding temperature, and hydraulic cylinders for maintaining a selected inwardly directed pressure on the tapered rams. With the hot-press evacuated and the loaded tool at the desired temperature, the cylinders are actuated to apply the selected pressure to the rams. The rams in turn expand the segmented core to maintain the nested components in compression against the restraining member. These conditions are maintained until the confronting faces of the nested components are joined in a continuous, uniform bond characterized by high thermal conductivity.

24569 (PB—299938) **Improved light scattering dust monitor. Open file report (final) 3 August 1977-31 May 1978.** Lilienfeld, P. (GCA Corp., Bedford, MA (USA). GCA Technology Div.). 28 Feb 1979. Contract H0377092. 48p. NTIS, PC A03/MF A01.

The report describes the development, design, fabrication, and testing of a portable, battery-operated, light scattering monitor for the rapid measurement of the concentration of respirable dust in mining environments. This instrument incorporates state-of-the-art design characteristics and makes use of advanced solid-state components both for light emission as well as for its detection. The use of a pulsed light source combined with synchronous signal detection minimizes drift problems and optimizes the sensitivity of the measurement. Simplicity of operation, reliability and ruggedness, light weight as well as improved performance were salient objectives of this instrument development program. Continuous clean-air flow screening of all critical optical surfaces, and optimized optical detection and electronic signal processing design resulted in about a hundred-fold decrease of noise and drift with respect to precursor instruments. Equivalent mass concentration measurements as low as 10 micrograms per cubic meter can be routinely performed with time constants of about 2 seconds.

24570 (SAND—80-0029C) **Optically coupled microwave switch.** Kiehl, R.A.; Drury, D.M. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 14p. (CONF-800521—1). Dep. NTIS, PC A02/MF A01.

From Symposium digest; Washington, DC, USA (28 May 1980).

A new mocrowave switch that uses lightwaves to couple microwave energy between its ports is shown to offer outstanding performance in terms of on/off ratio and reverse isolation while exhibiting a state independent input impedance.

24571 (SAND—80-0408C) **Bell Canyon Test (BCT) instrumentation development.** Cook, C.W.; Kinabrew, C.B.; Lagus, P.L.; Broce, R.D. (Sandia National Labs., Albuquerque, NM (USA); Systems, Science and Software, La Jolla, CA (USA)). May 1980. Contract EY-76-C-04-0789. 32p. (CONF-800527—4). NTIS, PC A03/MF A01.

From International BHP symposium; Columbus, OH, USA (7 May 1980).

The instrumentation used to assess the performance of the BCT plug and the future direction of instrumentation development are discussed. The BCT was initiated with a timed-release packer system below the plug; six time-released tracer gas bottles were included to provide a method of measuring permeability through the plugged region. A geophone package installed above the plug verified the initial operation of the below-the-plug system. In addition to tracer gas arrival times, fluid buildup and shut-in pressure measurements were made with current oil field systems - DMR (Digital Memory Recorder) and CWL (Conductor Wire Line) - to evaluate plug performance. A probe for measuring discrete fluid levels, fluid conductivity pressure, and temperature above a borehole plug has been developed. The conductivity measurement provides a rough measure of dissolved salts that can be useful in identifying the source

of the water. Development has started on two probes that can be grouted in place to monitor the leakage of brine past a plug. A wireline closed circuit TV capable of operating underwater in 5000-foot-deep holes is being set up to ascertain the wellbore conditions.

24572 (UCID—18622) **Noise characterization of the linear CCD.** McConaghy, C.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1980. Contract W-7405-ENG-48. 21p. NTIS, PC A02/MF A01.

Work in evaluating the noise performance of the linear charge-coupled devices (CCD) is summarized. The noise determines the minimum amplitude signal the CCD is capable of capturing and therefore is one of the prime parameters in determining dynamic range. The noise after correlated double sampling and correction of some ground loops will be shown equivalent to 150 rms electrons at the floating diffusion sensor on the CCD.

24573 (UCRL—84295) **LLL calibration and standards facility.** Campbell, G.W.; Elliott, J.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Apr 1980. Contract W-7405-ENG-48. 10p. (CONF-800534—1). NTIS, PC A02/MF A01.

From Seminar series on traceability for ionizing radiation measurements; Gaithersburg, MD, USA (8 May 1980).

The capabilities of Lawrence Livermore Laboratory's Calibration and Standards Facility are delineated. The facility's ability to provide radiation fields and measurements for a variety of radiation safety applications and the available radiation measurement equipment are described. The need for national laboratory calibration labs to maintain traceability to a national standard are discussed as well as the areas where improved standards and standardization techniques are needed.

24574 **Enhanced neutral-beam divergence due to imperfect magnetic shielding.** Conrad, J.R. (Nuclear Engineering Department, University of Wisconsin, Madison, Wisconsin 53706). *J. Appl. Phys.;* **51**: No. 6, 2957-2960(Jun 1980).

A previous calculation of neutral-beam divergence due to imperfect magnetic shielding of the gas-cell neutralizer is generalized to include the case in which the intrinsic magnetic-field—free divergence of the beam is finite.

24575 **Piezoelectric photoacoustic detection: Theory and experiment.** Jackson, W.; Amer, N.M. (Applied Laser Spectroscopy Group, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Appl. Phys.;* **51**: No. 6, 3343-3353(Jun 1980).

The theory of piezoelectric photoacoustic spectroscopy is developed for condensed-matter samples. Treating the sample as an elastic layer and neglecting the transducer's effect on the sample, the three-dimensional uncoupled quasistatic thermoelastic equations are solved using a Green's function for the stress. An expression for the dependence of the signal on absorption, modulation frequency, thermal properties, and mechanical properties of the sample is derived. The theoretical predictions are experimentally verified, the sources of noise are analyzed, and the noise equivalent power is estimated. Finally, considerations for detector optimization are discussed.

24576 **Differential light scattering photometer for rapid analysis of single particles in flow.** Bartholdi, M.; Salzman, G.C.; Hiebert, R.D.; Kerker, M. (Memorial Sloan Kettering Cancer Center, New York, New York 10021). *Appl. Opt.;* **19**: No. 10, 1573-1581(15 May 1980).

A differential light scattering photometer has been developed for rapid size analysis of single particles in flow. A fluid stream carrying individual particles in single file intersects a focused laser beam at the primary focal point of an annular strip of an ellipsoidal reflector situated in a scattering chamber. The light scattered from polar angles θ=2.5—177.5 ° at azimuthal angles phi=0 and 180 °, spanning a circle of 355 °, is reflected a circular array of 60 photodiodes. The signal processing electronics and computer storage can accept 32 signals/particle at rates up to 1000 particles/sec. Photometer performance is tested by comparing measured responses from individual spherical particles with angular scattering patterns calculated for the particular detector geometry. These patterns exhibit the required symmetry in the two half scattering planes. Response measurements for eight samples with particle diameters of 1.1, 2.7, 5.0, 7.9, 10.0, 12.5, 15.6, and 19.5 μm are consistent with calculated size-response curves. The composition of a mixture of five components with particle diameters of 1.1, 5.0, 10.0, 15.6, and 19.5 μm is determined from an analysis of light scattering measurements at various forward-scattering angles.

24577 **High-resolution photoacoustic thermal-wave microscopy.** Rosencwaig, A.; Busse, G. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Appl. Phys. Lett.;* **36**: No. 9, 725-727(1 May 1980).

Experiments on photoacoustic thermal-wave microscopy are presented, for the first time, at high resolution. Using piezoelectric detection and a modulation frequency of 185 kHz, we obtain a thermal-wave resolution of ~7 μm. We show that the photoacoustic phase signal provides true thermal-wave imaging even in the presence of surface features with strong optical contrast.

24578 **Micromagnetic susceptometer.** Nave, S.E.; Huray, P.G. (Department of Physics and Astronomy, University of Tennessee, Knoxville, Tennessee 37916). DOE-AS05-79ER10348;EY-76-S-05-4447;W-7405-ENG-26. *Rev. Sci. Instrum.;* **51**: No. 5, 591-596(May 1980).

A variable temperature (4.2 K to 300 K) micromagnetic susceptometer has been designed to maximize sensitivity to the magnetic flux produced by small samples. The susceptometer is based upon a superconductive flux sensor which measures the magnetic flux through a set of coils due to a sample magnetized in a uniform field. A minimum measurable volume susceptibility of 7.5 x 10^{-8} (emu) for a 1 microgram sample of curium has been achieved giving an increase in sensitivity of two orders of magnitude over Faraday devices designed for microgram metallic samples.

24579 **Novel photographic method of recording images from cellulose nitrate film.** Begay, F.; Grilly, J.M. (University of California, Los Alamos Scientific Laboratory, P. O. Box 1663, Los Alamos, New Mexico 87545). *Appl. Opt.;* **19**: No. 8, 1217-1218(15 Apr 1980).

A dark-field illumination method is presented that produces a high contrast image of data recorded on film.

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 23586, 23696

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

24580 (MLM—2708(OP)) **Role of surface chemistry in the ignition of pyrotechnic materials.** Moddeman, W.E.; Collins, L.W.; Wang, P.S.; Wittberg, T.N. (Mound Facility, Miamisburg, OH (USA); Dayton Univ., OH (USA). Research Inst.). 1980. Contract AC04-76DP00053. 17p. (CONF-800713—6). NTIS, PC A02/MF A01.

From 7. international pyrotechnics seminar; Vail, CO, USA (14 Jul 1980).

The surface chemistry of fuels has been shown to play a key role in the ignition of pyrotechnic materials. Since these fuels are usually easily oxidized, the surface must provide protection from undesirable oxidation processes such as pyrophoricity while permitting the desirable pyrotechnic reactions. For both titanium and aluminum, these criteria are met by metal oxide coatings which control the accessibility of the fuel to the oxidizer. However, we have shown that the mechanisms through which this control is exerted are substantially different. The ignition of titanium based pyrotechnics seems to be kinetically controlled by the dissolution of the titanium oxide coating to generate a reactive surface for the pyrotechnic reaction. Reactions of aluminum seem to depend on diffusion of aluminum (or oxygen at higher temperatures) through its oxide coating. It was also shown that the accessibility of aluminum can be improved by alloying.

24581 (MLM—2709(OP)) **Power independent ignition energy measurements.** Mohler, J. (Mound Facility, Miamisburg, OH (USA)). 1980. Contract AC04-76DP0005. 11p. (CONF-800713—7). NTIS, PC A02/MF A01.

From 7. international pyrotechnics seminar; Vail, CO, USA (14 Jul 1980).

A portion of the electrical energy supplied to hot-wire ignitable materials is dissipated, largely through thermal conduction, to the unignited portion of the charge and to the containment and igniter system. The remainder of the energy deposited by the igniter wire raises the mass of material required for sustained reaction to the critical reaction temperature. The amount of energy dissipated is a direct function of the time from first application of power, to ignition. Time to ignition can be controlled by altering firing pulse power. Integration of the power pulse from start until ignition yields the ignition energy. Repetition of this procedure at different power levels permits one to plot energy versus firing time. Since conduction losses are time dependent, extrapolation of the resulting curve to zero time yields an ignition energy value that is independent of losses due to thermal conduction. A key to the success of the procedure is accurate observation of ignition time. It was found that the reaction energy released at ignition causes a discernible deflection in the firing current record. By comparison of light emission and current traces, it was found that the onset of deflagration occurs at the inflection point of the current trace deflection. This procedure has

been successfully applied to hot pressed thermite samples, yielding ignition energies that are in qualitative agreement with the expected sensitivities of the samples.

24582 (MLM—2710(OP)) **Thermal and electrostatic initiation of TiH/sub x/ based pyrotechnics.** Collins, L.W. (Mound Facility, Miamisburg, OH (USA)). 1980. Contract AC04-76DP00053. 10p. (CONF-800713—8). NTIS, PC A02/MF A01.

From 7. international pyrotechnics seminar; Vail, CO, USA (14 Jul 1980).

The thermal and electrostatic initiations of TiH/sub x/ based pyrotechnics have been investigated to determne the material properties which influence these processes. Controlled electrostatic sensitivity experiments showed that the initiation reaction for TiH/sub x/ $KC1O_4$ pyrotechnic involved a reaction of the fuel with oxygen gas an that the $KC1O_4$ chemically interacts with the titanium to desensitize the material to electrostatic ignition. Other factors which influence the initiation process were also identified. As a result to these experiments, a new theory for the electrostatic initiation of TiH/sub x/ based pyrotechnics has emerged which relates the sensitivity to ignition to the chemistry of the titanium oxides which coat the metal particles. Thermal ignition of the TiH/sub x/$KC1O_4$ was whown to be controlled by chemical processes associated with the titanium fuel. DTA experiments were correlated with Auger spectroscopic measurements to demonstrate the role of the dissolution of the oxide coating in the thermal ignition of titanium.

24583 (SAND—80-0355C) **Design and evaluation of progressively burning pyrotechnic formulations.** Austing, J.L.; Cooper, P.W. (IIT Research Inst., Chicago, IL (USA); Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 24p. (CONF-800713—1). NTIS, PC A02/MF A01.

From 7. international pyrotechnics seminar; Vail, CO, USA (14 Jul 1980).

The design and evaluation of a pyrotechnic that burns for 2 ms and generates gas cubically with time is described. The charge is a mixture of two aluminum-plated pyrotechnics, viz., aluminum-potassium perchlorate (Al-$KCl0_4$) and aluminum-vanadium pentoxide (Al-V_2O_5). The Al-$KCl0_4$ is a gas generator, each gram of which produces 320 cc of gas (STP); the Al-V_2O_5, on the other hand, is a gasless pyrotechnic. Progressive generation of gas is achieved by utilizing mixtures of two pyrotechncs in increments that are progressively richer in gas generant, over a range of 14.6% to 100% Al-$KCl0_4$ by weight. The deflagration rate of the system is a function of the Al-$KCl0_4$ content, and ranges from 16.2 in./msec for a mixture with 14.6% Al-$KCl0_4$ by weight to 30.0 in./msec for pure Al-$KCl0_4$. An evaluation of the pyrotechnic charge fired in air showed that the design goals were adequately achieved. The growth of the gas cloud was monitored by high speed Fastax photography. Two criteria were utilized to verify the performance: (a) a plot of gas cloud volume as a function of time on logarithmic coordinates approached and maintained the required slope of 3, and (b) a plot of cloud diameter versus time on these coordinates achieved a slope of 1. In addition, the gas specific volume maintained a consistent value of about 27,000 cc/g of reacted Al-$KCl0_4$ throughout the 2.0-ms burning time.

24584 (UCRL—83727) **Modeling propellant combustion interacting with an eroding solid surface.** Buckingham, A.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 May 1980. Contract W-7405-ENG-48. 12p. (CONF-800620—2). NTIS, PC A02/MF A01.

From 16. AIAA-SAE-ASME joint propulsion conference; Hartford, CT, USA (30 Jun 1980).

A computatonal model of turbulent combustion flow acting on and influenced by an eroding wall surface is introduced. The combustion flow field is particle laden. Significant particulate mass loading occurs in the immediate neighborhood of the wall as a result of erosion products issuing from the deteriorating solid surface. In addition, cases are considered in which a substantial particle mass loading develops near the wall as a result of finely divided (sub micron diameter) particulates such as TiO_2 and talcum powder which are added to suppress erosion. In addition to statistical turbulent field particle flow interaction, the model includes multi-component molecular diffusion processes, and gas phase, gas/surface and or solid surface chemical reactions. Results indicate that despite the unsteady flow conditions, a limiting erosion rate is approached. This occurs as a result of the effective blowing off of the issing vapor phase products. The blowing reduces the gradients driving the incident combustion heat and mass transfer. An analogy is drawn to unsteady, ablative, heat transfer and thermal/material response in hypersonic aerodynamics. Surfaces investigated, at present, include bare steel and refractory metal coated steel walls.

24585 **Effect of a chemical inhomogeneity on steady-state detonation velocity.** Engelke, R. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Fluids;* **23**: No. 5, 875-880(May 1980).

The detonation behavior of the liquid explosive, nitromethane, sensitized by the liquid organic base, diethylene triamine, has been studied experimentally. The work to be described complements earlier work concerning the effect of physical impurities on steady detonation behavior. By interpretation of detonation-velocity measurements, the following three goals are reached: (1) The evidence that physical inhomogeneities (usually voids) produce the downward concave region of the diameter-effect curves of condensed high explosives is enhanced; (2) the hypothesis that homogeneous materials have linear diameter-effect curves is placed on a firmer basis; and (3) the experimental evidence indicates that the sensitizing material has altered the effective chemical kinetics and consequently, has produced an explosive with a shorter one-dimensional reaction zone. A remarkably small amount of the chemical impurity produces a significant reduction of the nitromethane failure diameter; e.g., addition of one molecule of the amine to 5500 molecules of nitromethane reduces the failure diameter by 43%. A discussion is given which attempts to relate this high sensitivity to a molecular isomer of nitromethane (the "aci" form) whose presence is favored in basic solutions.

WEAPONRY

REFER ALSO TO CITATION(S) 24192, 24635

EXPLOSION DETECTION

24586 **Microprocessor-controlled time domain reflectometer for dynamic shock position measurements.** Virchow, C.F.; Conrad, G.E.; Holt, D.M.; Hodson, E.K. (EG&G, Inc., Los Alamos, New Mexico 87544). *Rev. Sci. Instrum.;* **51**: No. 5, 642-646(May 1980).

Time-domain reflectometry is used in a novel way to measure dynamically shock propagation in various media. The primary component in this measurement system is a digital time domain reflectometer, which uses local intelligence, a Motorola 6800 microprocessor, to make the unit adaptable and versatile. The recorder, its operating theory and its method of implementation are described and typical data are reviewed. Applications include nuclear explosion yield estimates and explosive energy flow measurements.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

24587 (PB—300384) **Development of questionnaires for various emission inventory uses. Final report.** Hulman, P.; Collins, C. (Radian Corp., Austin, TX (USA)). Jun 1979. Contract EPA-68-02-2608. 114p. NTIS, PC A06/MF A01.

This report was written to act as a guide for agencies interested in developing emission inventory mail-out questionnaires. It addresses both the physical and psychological constraints on questionnaire design. The information provided is based on the knowledge of agencies and individuals that have experience in the art of questionnaire design. The first section discusses the choice of mail-out questionnaires over other information-gathering methods. The second section describes the individual elements of a mail-out questionnaire - the cover letter, the instructions and the questions - and what should be included in each. The third section considers design considerations for maximizing the return rate and the accuracy. Formulation of appropriate questions is also addressed. The formatting of a questionnaire for computer input and the use of a computer's capabilities are described in Section 4. Follow-up procedures are discussed in Section 5. Appendices include sample questionnaire elements.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 23513, 23514, 23523, 23532, 23568, 23569, 24027, 24037, 24038, 24352, 24353, 24354, 24356, 24545, 24546, 24547, 24643, 24644, 24663, 24769, 24776

24588 (ANL/EES-TM—83) **Emissions and effluent control costs of the US pulp and paper industry.** Grogan, P. (Argonne National Lab., IL (USA)). Dec 1979. Contract W-31-109-ENG-38. 34p. Dep. NTIS, PC A03/MF A01.

This report is a compilation of data for an assessment of environmental impacts of the US pulp and paper industry. That assessment will be part of a prototype study of the impacts of environmental legislation on industrial location patterns. The data

reported here were gathered from published information and are estimates, by unit process, of emission coefficients for water and air emissions and solid waste. Processes considered are pulping, bleaching, papermaking, and energy conversion operations. Relevant environmental standards are presented, and control technologies required to meet new source performance standards are discussed. Cost estimates of the required control technology are reported on the basis of plant capacity.

24589 (CONF-800309—5) **Aerosols and climate.** Kellogg, W.W. (National Center for Atmospheric Research, Boulder, CO (USA); Aspen Inst. for Humanistic Studies, CO (USA)). 1980. Contract AC02-79EV10281. 18p. NTIS, PC A02/MF A01.

From International workshop on the energy/climate interactions; Munster, F.R. Germany (3 Mar 1980).

The atmospheric burden of particles, or aerosols, has been measurably increased by human activities, especially in industrialized regions and those where slash-burn agricultural practices are followed. Some of these aerosols are directly produced when fossil fuels or other materials are burned (soot, smoke, fly ash); others are the result of photochemical reactions involving organic molecules, oxides of nitrogen, and sunlight (smog); and a third source is the oxidation of sulfur dioxide, produced when sulfur-bearing fuel is burned, to sulfuric acid thereby forming sulfate particles of droplets. In all cases, the resulting aerosols scatter and absorb both solar and infrared radiation, and therefore they influence the atmospheric heat balance. The question is the way in which they influence it, and the geographical and extent of this influence.

24590 (COO—4965-1) **Impact of gaseous sulfur and aerosols produced by power plants on the CCN budget. Progress report, September 1, 1978-August 31, 1979.** Saxena, V.K. (Utah Univ., Salt Lake City (USA). Dept. of Meteorology). Mar 1980. Contract AC02-78EV04965. 34p. Dep. NTIS, PC A03/MF A01.

A field experiment was carried out over Lake Michigan with an aim to delineate cloud-aerosol interactions. The PNL DC3 aircraft was used as an observational platform and a network of ground stations collected samples of precipitation which consisted of liquid phase during the early part of November and of solid phase during the January flights. The south, south-westerly surface winds were preferred in order to investigate the modification in the physiochemical characteristics of the sulfate-rich aerosol during its passage over the lake and before its involvement in clouds. A cloud condensation nucleus (CCN) spectrometer was installed in the DC3 which had the capability of making simultaneous measurements of Aitken nuclei concentration, cloud droplet size distribution, LWC, and SO_2 concentration. Cloud water was also collected for later chemical analysis through direct cloud penetrations. The CCN spectrometer measurements revealed the CCN enrichment within the subcloud layer and suggested that the cloud formation may be as important as the microphysics in evolving the droplet size spectra of clouds that were investigated over Lake Michigan.

24591 (DOE/EV/10281—1) **Consequences of a hypothetical world climate change produced by increased atmospheric carbon dioxide. Progress report, 1 September 1979-31 April 1980.** Roberts, W.O. (Aspen Inst. for Humanistic Studies, Boulder, CO (USA)). May 1980. Contract AC02-79EV10281. 8p. Dep. NTIS, PC A02/MF A01.

Progress is reported on a research program seeking to understand the effects of increased global levels of atmospheric CO_2 as a result of human activities. An outline of the major social, economic, geopolitical and ethical issues to be faced as a result of global warming is being attempted. Groundwork is being laid for a longer-term effort to delineate possible strategies to meet the predicted challenges. (ACR)

24592 (DOE/TIC—11203) **Formaldehyde monitoring program: development of sampling and analysis procedures. Report to the Consumer Product Sampling Commission.** Matthews, T.G.; Hawthorne, A.R.; Metcalfe, C.E.; Gammage, R.B. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 44p. NTIS, PC A03/MF A01.

A formaldehyde monitoring program has been developed to assist in the development of an indoor air quality standard for formaldehyde. Within the constraints of a five-month investigation, a diversified set of sampling and analysis techniques and instrumentation have been reviewed or experimentally evaluated to provide a qualified assessment of practical methods for formaldehyde analysis of the home environment, available at present or with further research and development. Emphasis has been placed upon simple, low-cost sampling and analysis techniques with minimal personnel training requirements, suitable for large-scale screening analyses for formaldehyde. Two categories of formaldehyde analysis are recommended; the measurement of a time weighted average concentration to determine an integrated formaldehyde exposure, and quasi-real-time formaldehyde determinations. The most promising formaldehyde monitoring techniques under experimental development or evaluation are summarized with respect to cost, personnel training requirements and an anticipated time frame for commercial availability.

24593 (EPA—600/9-79-015) **Bibliography of the Interagency Energy/Environment R and D Program.** Jacoff, F.S. (ed.). (Environmental Protection Agency, Washington, DC (USA)). Aug 1979. 334p. NTIS.

The Interagency Energy/Environment Research and Development Program, which is comprised of more than a dozen federal agencies and departments, is coordinated by the Office of Energy, Minerals and Industry within EPA's Office of Research and Development. The Interagency Program integrates research efforts in two main categories: health and environmental effects of energy systems and development of environmental control technologies. This bibliography lists publications resulting from research and development (R & D) performed under the auspices of the Interagency Program. The publications contained herein range from the Program's most current R & D and date back to the Program's inception in 1975. It has been designed to be used with three companion documents, each of which explores different facets of the Program.

24594 (EPA—600/9-79-016) **Fiscal Year 1977 Research Program Abstracts of the Interagency Energy/Environment R & D Program.** Jacoff, F.S. (ed.). (Environmental Protection Agency, Washington, DC (USA)). Aug 1979. 243p. NTIS.

Administered by the Office of Energy, Minerals and Industry within EPA's Office of Research and Development, the Interagency Energy/Environment Program plans, coordinates, and funds research and development on the health and environmental effects and on control technologies related to all forms of energy development. This document contains the project-level descriptions of most of the research and development projects funded by the Interagency Program during FY 1977. The two major sections of this document are environmental control technology and health and environmental effects, which correspond to the two major program research areas. These research sections are further divided into the following specific research categories: control technology - fuel processing, preparation, and advanced combustion; fuel extraction; environmental impacts of conventional and advanced energy systems; flue gas sulfur oxide control; nitrogen oxide control; and flue gas particulate control. Health and environmental effects are discussed as to: ecological effects; transport and fate; measurement systems and instrumentation; and health effects. Pertinent information contained within each project description includes project title, funding, project officer and affiliation, principal investigator and affiliation, project milestones, and abstract.

24595 (NTIS/PS—79/1058) **Nitrogen oxide air pollution. Part 2. Detection and analysis. Volume2. 1976-August, 1979 (a bibliography with abstracts). Report for 1976-August 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Oct 1979. 211p. NTIS PC N01/MF N01.

Techniques and equipment used in the gas analysis of ambient atmospheres, exhaust emissions, and flue gases are cited in the bibliography. (This updated bibliography contains 204 abstracts, 41 of which are new entries to the previous edition.)

24596 (NTIS/PS—79/1059) **Nitrogen oxide air pollution. part 3. atmospheric chemistry (a bibliography with abstracts). Report for 1964-August 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Oct 1979. 275p. NTIS PC N01/MF N01.

Photochemical air pollution models, smog chemistry and reactivity, and SSt exhaust effects are covered in the bibliography. Auroral and upper atmospheric chemistry, and photochemistry of naturally occurring nitrogen oxides are excluded. (This updated bibliography contains 268 abstracts, 44 of which are new entries to the previous edition.)

24597 (NTIS/PS—79/1061) **Nitrogen oxide air pollution. Part 5. Emissions studies. Volume 2. 1975-1977 (a bibliography with abstracts). Report for 1975-77.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Oct 1979. 202p. NTIS PC N01/MF N01.

Research reports on emissions from both stationarty and mobile sources, emissions factors, regional emission inventories and general studies are cited. Nitrogen oxide detection and analysis, industrial control techniques, atmospheric chemistry, adn biological effects are covered in Parts 1 through 4. (This updated bibliography contains 195 abstracts, none of which are new entries to the previous edition.)

24598 (NTIS/PS—79/1062) **Nitrogen oxide air pollution. Part 5. Emissions studies. Volume 3. 1978-August, 1979 (a bibliography with abstracts). Report for 1975-August 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Oct 1979. 119p. NTIS PC N01/MF N01.

The bibliography cites studies on emissions from both stationary and mobile sources, emissions factors, regional emission inven-

tories, and general studies. Air quality data is excluded. Nitrogen oxide detection and analysis, industrial control techniques, atomospheric chemistry, and biological effects are covered in Parts 1 through 4. (This updated bibliography contains 112 abstracts, 78 of which are new entries to the previous edition.)

24599 (PB—297525) **Transortation Control Plan. Volume 3: Technical Documentation.** Anderson, J.H.; Fostel, H.; DeHart, G. (Regional Planning Council, Baltimore, MD (USA)). Sep 1978. 105p. NTIS, PC A06/MF A01.

The Transportation Control Plan for the Baltimore metropolitan area sets forth the actions that will be taken by the region between now and 1987 to reduce the amount of air pollution caused by motor vehicles. Volume III contains technical documentation of emissions inventory and travel impact calculations, as well as the assumptions underlying the evaluation of the control measures.

24600 (PB—299639) **Haos quality assurance final report: criteria pollutants. Volume I. Final report.** (Radian Corp., Austin, TX (USA)). Dec 1978. 119p. NTIS, PC A06/MF A01.

The Houston Area Oxidants Study (HAOS) is a comprehensive air pollution research study composed of a group of separate projects. The study was undertaken to investigate, among other things, the causes and impacts of haze and airborne oxidants in Houston and Southeast Texas. A comprehensive quality assurance program was conducted in conjunction with the monitoring studies to determine the validity and comparability of the data obtained during the monitoring phase. Audits were conducted for the following parameters: ozone, NOx, SO2, total hydrocarbons and methane, CO, and total suspended particulates. The resulting data are presented in this report. The results of the audits were generally good and demonstrated the validity and comparability of the data taken by the diverse monitoring groups. Although the SO2 and CO audit data were generally low and variable, good agreement was obtained for ozone, oxides of nitrogen, THC, CH4, and TSP. Problems uncovered during the audits were reported to the responsible agency or contractor for their consideration and appropriate corrective action.

24601 (PB—299640) **HAOS quality assurance final report: noncriteria pollutants. Volume II. Final report.** (Radian Corp., Austin, TX (USA)). Mar 1979. 132p. NTIS, PC A07/MF A01.

The Houston Area Oxidants Study (HAOS) is made up of separate but interrelated technical projects designed to investigate the causes and impacts of airborne oxidants and haze in Houston and Southwest Texas. The purpose of the quality assurance portion of the study was to perform periodic observations, calibrations, and control sample audits to determine the validity and comparability of the data from the monitoring programs. Independent sensor audits or audit observations were conducted on the following perimeters: detailed hydrocarbons, PAN, total oxidants, human visibility, light scattering, visibility using telephotometry respirable particle sampling and analysis aeroallergens, UV radiation, upper air meteorological measurements, and aldehydes. There were no known standards for aeroallergens, UV radiation, and pibal measurements. Therefore, observations of actual ambient data from one or more laboratories or monitoring groups were made to determine relative differences. Also, due to the highly reactive nature of some standard materials (detailed hydrocarbons, PAN, and aldehydes) used to perform audits and calibrations, it was not always possible to determine if sample handling or degradation had occurred between audit sample preparation and analysis by the monitoring agency or contractor. Approved standard reference methods to calibrate and audit some of the non-criteria pollutant sensors (detailed hydrocarbons, PAN, UV radiation, telephotometry, aeroallergens and aldehydes) were not available. This made accuracy determinations difficult, if not impossible. Consequently, it was judged that it was more important to look for trends in the audit data which might explain any anomalies in the monitoring data, or which might identfy problems in a particular agency procedures.

24602 (PB—299643) **Airborne aeroallergen measurements in Houston, Texas. Final report.** Ivy, J.T. (Southwest Research Inst., San Antonio, TX (USA)). Mar 1979. 115p. NTIS, PC A06/MF A01.

Three principal objectives were established for the aeroallergen study, including sampling of Houston air for aeroallergens on a daily schedule for a period of four months beginning in July, 1977, using a documented, reliable, reproducible method; identifying and documenting major aeroallergens which might contribute to allergic responses in humans; and, determining and documenting the accuracy and precision of the qualitative and quantitative determinations required above. The sampling program provided adequate data for the support of the analysis of the health effects data. Daily variations and seasonal trends of aeroallergens were observed which were comparable with expectations for the Houston area. For application to analysis of allergic response, aeroallergens present in the Houston area may be categorized in three major groups: ragweed pollen (Ambrosia), grass pollens (Gramineae), and total mold spores. This conclusion is based on the daily and seasonal variations observed in this study, consultations with area allergists, and review of the available literature.

24603 (PB—299672) **Controlling pollution from the manufacturing and coating of metal products. 1. Metal coating air pollution control. Technology transfer report.** (Environmental Protection Agency, Cincinnati, OH (USA). Office of Technology Transfer; JACA Corp., Fort Washington, PA (USA); Snell (Foster D.), Inc., Cleveland, OH (USA)). May 1977. 107p. NTIS, PC A06/MF A01.

The first volume acquaints supervisory and management personnel in the industry with methods of reducing the emission of organic solvents to the atmosphere and helps them assess the costs.

24604 (PB—299673) **Controlling pollution from the manufacturing and coating of metal products. 2. Solvent metal cleaning air pollution control. Technology transfer report.** (Environmental Protection Agency, Cincinnati, OH (USA). Office of Technology Transfer; JACA Corp., Fort Washington, PA (USA)). May 1977. 75p. NTIS, PC A04/MF A01.

Volume 2 outlines for plant operators practical and proven techniques for controlling hydrocarbon emissions from metal cleaning operations, along with appropriate cost data.

24605 (PB—299726) **The calculation of long period mean pollutant concentrations in an urban atmosphere. Part II. Simulation of annual sulfur dioxide concentrations in Mexico City.** Lamb, R.G.; Levy, A.V.; Burkle, J. (IBM de Mexico S.A., Mexico City. Centro Cientifico de America Latina). Sep 1975. 125p. NTIS, PC A06/MF A01.

In Part I of this report, general formulas for the long term mean and mean square concentrations of linearly reactive pollutants were derived from Lagrangian diffusion theory. The derivation was achieved by subdividing the long term averaging interval into three disjoint domains designated the plume period, the stagnation period, and the transient period. Events in each domain are modeled separately and superposed to obtain the final estimate of the long term mean concentration. In Part II of this report the theory developed in Part I is applied to sulfur dioxide levels in Mexico City.

24606 (PB—299935) **An analysis of inspection-maintenance program options for Jefferson County, Kentucky. executive summary. Final report.** Bruch, A. (Engineering-Science, Inc., McLean, VA (USA)). Apr 1979. Contract EPA-68-02-2869. 32p. NTIS, PC A03/MF A01.

Inspection-maintenance program options differing according to concept, management and type of inspection were identified, scaled to Jefferson County, and comparative costed using a modular approach. Total costs were considered, including repair of vehicles, without regard for whom would meet these costs. Upon consideration of these comparative costs, and comparative benefits as well, the two low-cost options were selected for fuller consideration. These options, government-run and contractor-run central lanes, were then subjected to a more detailed and conventional cost analysis: capital costs; operating costs; annual costs; and first-year implementation costs to government. Finally, funding requirements and opportunities were considered.

24607 (PB—300336) **Evaluation of stationary source particulate measurement methods. Volume III. Gas temperature control during method 5 sampling. Interim report oct 73-February 1977.** Peters, E.T.; Adams, J.W. (Little (Arthur D.), Inc., Cambridge, MA (USA)). Jun 1979. Contract EPA-68-02-0632. 32p. NTIS, PC A03/MF A01.

A study was conducted to measure changes in gas temperature along the length of a Method 5 sampling train due to variations in stack gas temperature, sampling rate, filter box temperature and method for controlling the probe heating element. For each run condition, temperatures were measured in the stack, at ambient and at four internal and external positions along the sampling train at one minute intervals. Measurements were continued until the system was observed to reach a state of thermal equilibrium. The results from these experiments, presented herein, demonstrate that gas temperatures cannot be predicted or controlled on the basis of externally measured temperatures. The use of an internal thermocouple, having its reference junction at the back of the probe, to proportionally control the probe heater element is shown to provide a predictable gas temperature and a flat thermal profile along the system. This procedure for controlling gas temperature is recommended as a modification to Method 5.

24608 (PB—300337) **Evaluation of stationary source particulate measurement methods. Volume V. Secondary lead smelters. Interim report oct 73-June 1977.** Howes, J.E. Jr; Henry, W.M.; Pesut, R.N. (Battelle Columbus Labs., OH (USA)). Jun 1979. Contract EPA-68-02-0609. 40p. NTIS, PC A03/MF A01.

As part of an overall program to evaluate the EPA Method 5 procedure for measurement of particulate emissions, an experimental study was made of its specific applicability to secondary lead plant emissions. The study was carried out with two Method 5 sampling train systems operated simultaneously at a single point in the stack

emission stream. A series of six statistically designed tests was conducted over a 5-day period to obtain data on the reliability of Method 5, the sensitivity of the method to variation of such key parameters as sampling system temperature, filter media, and particulate loading and to characterize the chemical composition of the emissions. Comprehensive chemical analyses were made ofj particulates collected in the sampling system and from the baghouse control to ascertain if the sampling mode affected the composition of the particulate emissions. Essentially 100 percent of the particulates were accounted for by the chemical analyses. Compositional analysis of the gaseous species present in the stack gas stream also were performed. The results of the particulate and gas analyses do not indicate any chemical interactions with the sampling system components of the Method 5 train.

24609 (PB—300443) **Evaluation of particulate emission factors for vehicle tire wear. Final report.** Corvitti, J. (PEDCo-Environmental, Inc., Kansas City, MO (USA)). Jun 1979. Contract EPA-68-02-2585. 29p. NTIS, PC A03/MF A01.

Vehicle-related emissions are a major contributor to urban particulate concentrations. One of the vehicle-related emission sources is tire wear. It is estimated that 3.2 x 10 to the 8th power to 7.2 x 10 to the 8th power kg of tire wear debris are generated each year in the United States. Particles from tire wear have been identified by microscopic analysis as a significant component of samples taken from roadside high volume particulate samplers. The currently available emission estimate for tire wear, presented in Compilation of Air Pollutant Emission Factors (AP-42), is 0.20 g/veh-mi for a four-wheeled light duty vehicle. This emission factor is widely used in regional particulate analyses to estimate emissions from tire wear; however, this factor needs to be reviewed, based on studies and test data released since its publication.

24610 (PB—300458) **Air quality data for nonmetallic inorganic ions: NH4+, NO3-, SO4= from the National Air Surveillance Networks, 1976. Final report.** Fair, D.H.; Rhodes, R.C.; Evans, E.G.; Puzak, J.C.; Butler, F.E. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Monitoring and Support Lab.). Jun 1979. 78p. NTIS, PC A05/MF A01.

Samples collected during 1976 by the cooperating stations of the National Air Surveillance Networks (NASN) provided the data for summarizing the annual urban and nonurban concentrations of three nonmetallic inorganic ions in suspended particulate matter. The ions are ammonium nitrate and sulfate. Concentration data are presented as cumulative frequency distributions. The arithmetic and geometric means and standard deviations are also reported.

24611 (PB—300470) **A lagrangian photochemical air quality simulation model: adaptation to the St. Louis - Raps Data Base. Volume I. Model formulation. Final report.** Lurman, F.; Godden, D.; Lloyd, A.C.; Nordsieck, R.A. (Environmental Research and Technology, Inc., Westlake Village, CA (USA). Environmental Analysis Div.). Jun 1979. Contract EPA-68-02-2765. 152p. NTIS, PC A08/MF A01.

A Lagrangian photochemical air quality simulation model has been adapted to the St. Louis, Missouri/Illinois metropolitan region and the Regional Air Pollution Study (RAPS) aerometric and emissions data base. This adaptation was performed to provide a means for EPA to independently assess the validity of a state-of-the-art Lagrangian photochemical model. Chemical kinetic oxidation mechanisms involving hydrocarbons, nitrogen oxides and sulfur oxides and a vertical diffusion formulation developed by Environmental Research and Technology Inc. for modeling reactive pollutants in the troposphere are described. Methods for determining model input parameters are discussed and model results for ozone, nitrogen dioxide, carbon dioxide, sulfur dioxide, and sulfate are presented for three summer days in 1976. In considering so few simulations, no firm conclusions concerning model reliability are possible, although predicted pollutant concentrations are of reasonable levels. Most noteworthy for future users, the results suggest that the model may predict less ozone than is actually generated in St. Louis. Uncertainty in initial conditions of ozone and organic species is likely responsible for this discrepancy between observed and computed values.

24612 (PB—300471) **A lagrangian photochemical air quality simulation model: adaptation to the St. Louis - Raps Data Base. Volume II. User's manual. Final report.** Lurmann, F.; Godden, D.; Lloyd, A.C.; Nordsieck, R.A. (Environmental Research and Technology, Inc., Westlake Village, CA (USA). Environmental Analysis Div.). Jun 1979. Contract EPA-68-02-2765. 448p. NTIS, PC A19/MF A01.

A set of instructions have been compiled for use of a Lagrangian photochemical air quality simulation model adapted to the St. Louis, Missouri/Illinois metropolitan region and the Regional Air Pollution Study (RAPS) data base. The computer model, developed by Environmental Research and Technology, Inc., consists of a set of computer programs for the simulation of atmospheric transport, turbulent diffusion, and chemical kinetics of photochemical pollutants. The model is used to predict atmospheric concentrations of ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, and sulfate within an air column moving at the mean wind speed. Descriptions of the meteorological, source emissions, and air quality data requirements, as well as sample input and output files, are provided. the computational procedures for using the model and a listing of the computer code are included.

24613 (PB--300479) **Weekend/weekday differences in oxidants and their precursors. Final report.** Horie, Y.; Cassmassi, J.; Lai, L.; Gurtowski, L. (Technology Service Corp., Santa Monica, CA (USA)). Mar 1979. Contract EPA-68-02-2595. 150p. NTIS, PC A07/MF A01.

Differences between weekend and weekday oxidant and oxidant precursor concentrations in the Northeastern United States are examined. Statistical tests are employed to assess whether any differences in daily maximum oxidant concentrations are significant. Weekend/weekday differences in meteorology are also examined for any potential impact on weekend/weekday differences in oxidants. Oxidant concentrations are adjusted in an attempt to account for variations in meteorology, and weekend/weekday differences in the adjusted values are examined. Finally, statistical tests are used to determine significant differences in early morning oxidant precursor concentrations. The analyses revealed that oxidant concentrations downwind of major urban areas tend to be lower on weekends. However, the reductions are not as large as those observed in precursor concentrations within the major urban areas. Reductions in weekend oxidant concentrations at locations within the major urban areas are not as great as those at downwind locations.

24614 (PB--300481) **Study of the nature of ozone, oxides of nitrogen, and nonmethane hydrocarbons in Tulsa, Oklahoma. Volume I. project description and data summaries.** Eaton, W.C.; Decker, C.E.; Tommerdahl, J.B.; Dimmock, F.E. (Research Triangle Inst., Research Triangle Park, NC (USA)). Apr 1979. Contract EPA-68-02-2808. 219p. NTIS, PC A10/MF A01.

This volume describes the project and summarizes the data. The monitoring network consisted of eight RTI ground sites and two Tulsa City/County Health Department sites. An airborne measurements program employing a Piper Navaho B was an integral part of the study and is described in detail. Surface data are summarized through tables of mean daily concentrations, cumulative frequency distributions, and diurnal plots, etc. Also included in this volume are: descriptions and results of the quality control and quality assurance aspects of the field study; an appendix describing the sampling, and analytical methodology for GC/FID identificaton of hydrocarbons; and an appendix describing the sampling and analysis by GC/MS of volatile organic compounds collected on TENAX-GC polymer.

24615 (PB—300916) **Hydrocarbon characterization of agricultural waste burning. Final report.** Darley, E.F. (California Univ., Riverside (USA.). Statewide Air Pollution Research Center). Apr 1979. 55p. NTIS, PC A04/MF A01.

Emission factors were investigated for particulates, carbon monoxide, oxides of nitrogen, sulfur dioxide, total hydrocarbons, and several aldehydes obtained during simulated open burning of eight field and orchard crop residues. The field crops selected were barley, corn, rice, sorghum, and wheat; orchard crops were almond, grape, and peach. Field crops were burned as head and back fires, and orchard crops were burned in piles.

24616 (PB—300930) **Continuous air pollution source monitoring systems.** Jahnke, J.A.; Aldina, G.J. (Northrop Services, Inc., Research Triangle Park, NC (USA)). Jun 1979. Contract EPA-68-03-2561. 253p. NTIS, PC A12/MF A01.

This handbook provides the detailed information necessary to develop a continuous emissions monitoring program at a stationary source facility. Federal and State EPA requirements are given, including design and performance specifications and monitoring and date reporting requirements. Discussions of extractive sampling techniques and in-situ methods are presented, along with explanations of the analytical techniues used in currently marketed instrumentation. Methods for monitoring opacity, pollutant gases, and combustion gases, such as oxygen and carbon dioxide, are described. A detailed explanation of the EPA Performance Specification Test is given along with an explanation of the statistical procedures used to evaluate newly installed systems. Selection procedures for monitoring systems and specific instrumentation are included as a guide to the industrial engineer. Photographs of existing instruments and monitoring systems are presented along with explanatory diagrams to familiarize the reader with the equipment. References are givern for each topic discussed in the handbook. The handbook serves as a basic tool for continuous source monitoring, enabling the reader to refer to original research and development work for the initiation of a continuous monitoring program.

24617 (PB—301065) **Treatment categories for coal mine drainage. Final report January 1978-January 1979.** Schultz, H.L.; Koch, D.; Thompson, C.; Hereford, K. (Hittman Associates, Inc., Columbia, MD (USA)). Sep 1979. Contract EPA-68-03-2566. 30p. NTIS, PC A03/MF A01.

This effort involved the organization and statistical analysis of a large amount of data characterizing over 300 surface and underground coal mines and quantification of the pre- and post-treatment quality of their wastewaters. Only existing data, supplied to Hittman Associates by EPA, was utilized in this evaluation. The study objective was to determine whether the data supported the development of a separate Effluent Guidelines subcategory for coal-mining point source discharges to differentiate between eastern and western coal mining activities. An extensive effort was required to convert the data into a computerized format which would allow for expeditious statistical analysis.

24618 (PB—301242) **Inventory of sources with emissions of 25 to 100 tons per year subject to organic material regulations in Metropolitan Boston AQCR. Final report.** (Engineering-Science, Inc., McLean, VA (USA)). Jul 1979. Contract EPA-68-01-4146. 56p. NTIS, PC A04/MF A01.

An inventory of volatile organic compound emissions was conducted for sources in the Metropolitan Boston AQCR. Potential sources were identified using existing emissions data from the Massachusetts Department of Environmental Quality Engineering and from the U.S. EPA, Region I; Dun and Bradstreet industrial listings; and a listing of industrial concerns supplied by the Massachusetts Department of Employment Security. Potential sources were identified by four-digit SIC. Questionnaires were mailed to the selected sources. The returned questionnaires were reviewed, and emissions were estimated. The results were quantified in an inventory of sources with the potential to emit between 25 and 100 tons/year.

24619 (PB—301288) **SO_2 oxidation rate on well-characterized surfaces, a laboratory study. Final report 15 May 1978-14 May 1979.** Mohnen, V.A.; Hudson, J.B.; Cheng, R.J.; Menotti, F.; Stigliani, W. (State Univ. of New York, Albany (USA). Atmospheric Sciences Research Center). 1979. 68p. NTIS, PC A04/MF A01.

Results of a series of surface measurements involved in the oxidation of sulfur dioxide are reported. Measurements were made of the total sulfur uptake of samples maintained in static atmospheres of sulfur-containing gases and the dynamics of the interaction of various atmospheric gases with several laboratory-prepared vanadium oxide surfaces. The principal conclusion to date is that the rate of oxidation of sulfur dioxide on vanadium pentoxide melted onto a molybdenum holder is below the detectability of the analytical techniques employed. Neither direct measurement of product flux from the surface nor measurement of product buildup has provided unequivocal evidence of a surface reaction. Possible reasons for the non-reactivity of the vanadium oxide sample are discussed and possible promising areas for future research listed. Chemical and physical measurements of surface sulfate on coal and oil fly ash surfaces are reported and recommendations offered for future work.

24620 (PB—301294) **Detailed characterization of gaseous and size-resolved particulate pollutants at a south coast air basin smog receptor site: levels and modes of formation of sulfate, nitrate and organic particulates and their implications for control strategies. Final report November 1975-June 1978.** Pitts, J.N. Jr; Grosjean, D. (California Univ., Riverside (USA). Statewide Air Pollution Research Center). Jul 1979. 466p. NTIS, PC A20/MF A01.

A two-year research program was conducted to characterize gas phase pollutants, aerometric variables, visibility, aerosol elemental composition, and ambient levels and size distribution of particulate sulfate, nitrate, and ammonium at Riverside, a smog receptor site located at the eastern end of the California South Coast Air Basin (SCAB). These studies were supplemented by (a) laboratory studies of analytical techniques, including ion selective electrodes, effect of filter storage, aqueous extraction methods, and artifact nitrate formaton on various filters; (b) dual outdoor smog chamber studies of multiday irradiation of ambient air parcels, and (c) investigation of pollutant transport from the western part of the SCAB using wind roses and air trajectories. The data base thus generated was employed (1) to establish diurnal and seasonal profiles for gaseous and particulate pollutants, (2) to calculate sulfur and nitrogen gas-particle distribution factors, (3) to correlate sulfate and nitrate levels with indicators of photochemical and aqueous aerosol formation mechanisms, and (4) to develop relationships between visibility impairment, aerosol concentration and aerosol chemical composition.

24621 (PB—301366) **Epa chemical activities status report, first edition.** Merrick, E.T.; Ketcham, H.; Murphy, L.J. Jr; Slike, K. (Environmental Protection Agency, Washington, DC (USA). Office of Toxic Substances). Apr 1979. 319p. NTIS, PC A14/MF A01.

This Report is organized into four sections: (1) Alphabetized Chemical Name Reference Listing (an index of names used for chemicals included in the text); (2) EPA Chemical Activities Report (arranged sequentially by CAS Registry Number); (3) Chemical Name Synonym List (showing all synonyms for chemicals in the text, and arranged by CAS Registry Number); (4) Proposed Hazardous Waste Guidelines and Regulations (incorporating many items not assigned CAS Registry Numbers).

24622 (PB—301368) **Report on the progress of regulations to protect stratospheric ozone. Annual report 1978-79.** Bishop, F.S. (Environmental Protection Agency, Washington, DC (USA). Office of Toxic Substances). Aug 1979. 57p. NTIS, PC A04/MF A01.

This report reviews the progress made by EPA from March 1978 to August 1979 in regulating ozone depleting substances. In March 1978 EPA along with Food and Drug Administration (FDA) issued final rules prohibiting the manufacturing and processing of chlorofluorocarbons (CFCs) for nonessential aeroso! propellant uses. EPA continues its investigation of nonaerosol and miscellaneous CFC uses, including use as refrigerants, foam blowing agents, cleaning agents in the electronic and metal industries and as solvents. The EPA study includes several regulatory strategies to reduce CFC emissions, namely, (1) direct regulation, (2) economic incentives and (3) a conservation program. Because CFC emissions in any country may have adverse effects globally, the reduction of CFC emissions is an international concern. EPA is developing programs to investigate other substances or chemicals that may deplete the stratospheric ozone. In implementing the Clean Air Act and deciding whether and to what extent further regulation is necessary, EPA is continuing its studies of current developments in ozone processes, of adverse health and environmental consequences of ozone depletion, of technological capability to reduce emissions from major sources, and of the cost of achieving control.

24623 (PB—301384) **Atmospheric reaction products of organic compounds. Final report.** Hendry, D.G.; Kenley, R.A. (SRI International, Menlo Park, CA (USA)). Jun 1979. Contract EPA-68-01-5123. 90p. NTIS, PC A05/MF A01.

A procedure has been developed to predict the products from reaction of compounds in the atmosphere. The procedure is designed to be used in unreasonable-risk evaluations that include assessing new chemials for persistence and exposure in the environment. In this procedure, the relative importance of the three dominant reaction pathways--photolysis, reaction with OH radical, and reaction with ozone--are first determined for each compound. Then the products from each pathway that play a major role for that compound are estimated using the techniques outlined in the methods. The methods are applicable to a wide variety of compounds; however, as the structure of the compounds differ from the structures on which the procedures were based, the conclusions become tentative. It is belived, however, that this will be a minor fraction of the cases to which it is applied.

24624 **Impact of reduced infiltration and ventilation on indoor air quality.** Hollowell, C.D.; Berk, J.V.; Traynor, G.W. (Lawrence Berkeley Lab). *ASHRAE J.*; **21**: No. 7, 49-53(Jul 1979).

Reduced infiltration and ventilation rates in buildings, proposed as important energy conservation measures, can lead to elevated levels of indoor-generated air contaminants that may impair the health, safety, or comfort of occupants. Nitrogen dioxide, formaldehyde, and radon, three indoor-generated contaminants of particular concern in residential buildings, are discussed. Possible regulatory approaches for limiting exposure to indoor contaminants are mentioned. (1 diagram, 2 graphs, 16 references, 1 table)

24625 **Chemiluminescent process and detector for monitoring atmospheric contaminants.** Shaffer, R.E. US Patent 4,142,859. 6 Mar 1979. Filed date 23 Jun 1977. 9p.

The patent is concerned with a process and device for detecting impurities in the atmosphere by an intensity-time rate technique whereby chemiluminescent reaction curves are developed and found to be representative of specific materials. Hence, by comparing known intensity-time rate curves with curves had by actual measurings, the invention enables the user to discern many more materials never before detected. (Author)

24626 **Vapor emission recovery and measuring method and vapor recovery collection boot.** Cohen, J.B.; Principe, P.P. US Patent 4,138,880. 13 Feb 1979. Filed date 27 May 1977. 6p.

A testing method and an apparatus are described for use at service stations to establish whether gasoline refueling systems meet government regulations for gasoline vapor emission. The apparatus includes a boot used to surround a gasoline dispensing nozzle while delivering gasoline to an automobile gas tank. This boot is used to recover the emitted vapors directly from the vehicle-nozzle interface region and the recovered apors are drawn by a pump through a flow meter and delivered to an analyzer. The outputs of the flow meter and analyzer may be delivered to a computing device to determine the mass emission rare of hydrocarbons and the accumulated total hydrocarbon mass emitted.

24627 **Estimated dry deposition velocities of sulfur over the eastern United States and surrounding regions.** Sheih, C.M.; Wesely, M.L.; Hicks, B.B. (Argonne National Lab., IL). *Atmos. Environ.*; **13**: 1361-1368(1979).

Surface deposition velocities of sulfur dioxide and sulfate particles over the eastern half of the United States, southern Ontario, and nearby oceanic regions are computed for equations developed in

recent field experiments, for use in studies of regional-scale atmospheric sulfur pollution. Surface roughness scale lengths and resistances to pollutant uptake by the surface are estimated from consideration of land-use characteristics and the likely biological status of the vegetation. Midsummer conditions are assumed, but other seasons can be easily considered. Average deposition velocities for grid cells corresponding to half-degree increments of longitude and latitude are presented for a range of atmospheric stabilities.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 24646

24628 (CONF-791103—107) **Iodine-129 dose to the world population from the nuclear power industry.** Kocher, D.C.; Till, J.E. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 8p. Dep. NTIS, PC A02/MF A01.

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

Because of the 15.7 million-year half life for ^{129}I and the mobility of iodine in the environment, releases of ^{129}I result in potential radiological impacts on the entire world population essentially in perpetuity. This paper presents estimates of dose to the world population from releases of ^{129}I by the world nuclear power industry during the years 1975 to 2020.

24629 (DPSPU—80-30-1) **Environmental monitoring in the vicinity of the Savannah River Plant. Annual report for 1979.** (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract EY-76-C-09-0001. 61p. NTIS, PC A04/MF A01.

An extensive surveillance program has been continuously maintained since 1951 (before SRP startup) to determine the concentrations of radionuclides in a 1200-square-mile area in the environs of the plant and the radiation exposure of the population resulting from SRP operations. The results of this monitoring program are reported annually to the public. This document summarizes the 1979 results.

24630 (EMSL-LV—0539-36) **Offsite environmental monitoring report for the Nevada Test Site and other test areas used for underground nuclear detonations, January-December 1979.** Potter, G.D.; Grossman, R.F.; Bliss, W.A.; Thome, D.J.; Hopper, J.L. (Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring Systems Lab.). Apr 1980. Contract EY-76-A-08-0539. 106p. NTIS, PC A06/MF A01.

This report contains descriptions of pertinent features of the NTS and its environs, summaries of the EMSL-LV dosimetry and sampling methods, analytical procedures, and the analytical results from environmental measurements. Where applicable, dosimetry and sampling data are compared to appropriate guides for external and internal exposures of humans to ionizing radiation.

24631 (LBL—9814) **Radiation monitoring. Lecture 26, course on advances in radiation: International School of Radiation Damage and Protection, Erice, Italy, September 1979.** Thomas, R.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1979. Contract W-7405-ENG-48. 36p. NTIS, PC A03/MF A01.

The practices and rationales of radiation monitoring as applied at high-energy accelerator laboratories are presented. Area, environmental, and personal techniques are discussed and examples given. (ACR)

24632 (ORNL—5634) **HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide.** Moore, R.E. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 36p. NTIS, PC A03/MF A01.

The HARAD computer code, written in FORTRAN IV, calculates concentrations of radioactive daughters in air following the atmospheric release of a parent radionuclide under a variety of meteorological conditions. It can be applied most profitably to the assessment of doses to man from the noble gases such as ^{222}Rn, ^{220}Rn, and Xe and Kr isotopes. These gases can produce significant quantities of short-lived particulate daughters in an airborne plume, which are the major contributors to dose from these chains with gaseous parent radionuclides. The simultaneous processes of radioactive decay, buildup, and environmental losses through wet and dry deposition on ground surfaces are calculated for a daughter chain in an airborne plume as it is dispersed downwind from a point of release of a parent. The code employs exact solutions of the differential equations describing the above processes over successive discrete segments of downwind distance. Average values for the dry deposition coefficients of the chain members over each of these distance segments were treated as constants in the equations. The advantage of HARAD is its short computing time.

24633 (ORNL/TM—6874) **User's manual for DWNWND: an interactive Gaussian plume atmospheric transport model with eight dispersion parameter options.** Fields, D.E.; Miller, C.W. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 39p. NTIS, PC A03/MF A01.

The most commonly used approach for estimating the atmospheric concentration and deposition of material downwind from its point of release is the Gaussian plume atmospheric dispersion model. Two of the critical parameters in this model are σ/sub y/ and σ/sub z/, the horizontal and vertical dispersion parameters, respectively. A number of different sets of values for σ/sub y/ and σ/sub z/ have been determined empirically for different release heights and meteorological and terrain conditions. The computer code DWNWND, described in this report, is an interactive implementation of the Gaussian plume model. This code allows the user to specify any one of eight different sets of the empirically determined dispersion paramters. Using the selected dispersion paramters, ground-level normalized exposure estimates are made at any specified downwind distance. Computed values may be corrected for plume depletion due to deposition and for plume settling due to gravitational fall. With this interactive code, the user chooses values for ten parameters which define the source, the dispersion and deposition process, and the sampling point. DWNWND is written in FORTRAN for execution on a PDP-10 computer, requiring less than one second of central processor unit time for each simulation.

24634 (SLAC—228) **Annual environmental monitoring report, January-December 1979.** (Stanford Linear Accelerator Center, CA (USA)). May 1980. Contract AC03-76SF00515. 30p. NTIS, PC A03/MF A01.

Environmental monitoring results continue to demonstrate that, except for penetrating radiation, environmental radiological impact due to SLAC operation is not distinguishable from natural environmental sources. During 1979, the maximum measured neutron dose near the site boundary was not distinguishable from the cosmic ray neutron background. There have been no measurable increases in radioactivity in ground water attributable to SLAC operations since 1966. Because of major new construction, well water samples were not collected and analyzed during 1979. Construction activities have also temporarily placed our sampling stations for the sanitary and storm sewers out of service. They will be reestablished as soon as construction activities permit (mid 1980). Airborne radioactivity released from SLAC continues to make only a negligible environmental impact, and results in a site boundary annual dose of less than 0.3 mrem; this represents less than 0.3% of the annual dose from the natural radiation environment, and about 0.06% of the technical standard.

24635 (UCRL—83583) **Numerical simulation of self-induced rainout using a dynamic convective cloud model.** Molenkamp, C.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1980. Contract W-7405-ENG-48. 5p. (CONF-800708—1). Dep. NTIS, PC A02/MF A01.

From 8. international conference on cloud physics; Clermont-Ferrand, France (15 Jul 1980).

The hypothesis that self-induced rainout can occur is supported by observations in Hiroshima and Nagasaki, where deposition of weapons debris with precipitation occurred several km downwind of the burst point. This precipitation was initiated either directly by the nuclear weapons or by the ensuing fires. Simulation of the Nagasaki event with a convection cloud precipitation scavenging model, although fraught with many questionable assumptions, agrees surprisingly well with the observations and supports the hypothesis that self-induced rainout can occur.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 23527, 23659, 24618

REGULATIONS

REFER ALSO TO CITATION(S) 24353

24636 (PB—299959) **Compliance status of major air pollution facilities. Final report.** (Environmental Protection Agency, Washington, DC (USA). Div. of Stationary Source Enforcement). Jun 1979. 767p. NTIS, PC A99/MF A01.

This report is the ninth in a series of periodic reports presenting the probable compliance status and related facility information for major stationary sources of air pollution. The contents of this report were generated from the U.S. Environmental Protection Agency's Compliance Data System and are not intended to represent the true legal status of facilities with respect to applicable air pollution regulations but rather those facilities of interest to the States or the Agency for further investigation.

24637 (PB—300446) **The cost of clean air and water. Report to Congress.** (Battelle Columbus Labs., OH (USA)). Aug 1979. Contract EPA-68-01-4360. 345p. NTIS, PC A15/MF A01.

The report deals with the cost of compliance with the Clean Air Act and the Federal Water Pollution Control Act. In 1977, it was estimated that industries spent 12.8 billion dollars in incremental annual costs (including capital charges and operating and maintenance expenses) to comply with Federal air and water legislation. Federal, State and local governments spent $4.6 billion and consumers spent $5.8 billion directly on mobile source emission control. The study projects future incremental investment costs for the period 1977-1986 to be $79.7 billion as a result of the Clean Air Act and $61.6 billion due to the Federal Water Pollution Control Act. Model plant analysis was used to generate most of the cost estimate in the report.

24638 (PB—300480) **A review of standards of performance for new stationary sources - petroleum refineries.** Barrett, K.; Goldfarb, A. (Mitre Corp., McLean, VA (USA). METREK Div.). Jan 1979. Contract EPA-68-02-2526. 91p. NTIS, PC A05/MF A01.

This report reviews the current Standards of Performance for New Stationary Sources: Subpart J - Petroleum Refineries. It includes a summary of the current standards, the status of current applicable control technology, and the ability of refineries to meet the current standards. Compliance test results are analyzed and recommendations are made for possible modifications and additions to the standard, including future studies needed for unresolved issues.

24639 (PB—300835) **Balancing the objectives of clean air and economic growth: regulated markets in emission reductions. Interim report.** Foskett, W.A.; Klaus, D.M.; Haberle, J. (Urban Inst., Washington, DC (USA)). Jun 1979. Contract NBS-7-35822. 105p. NTIS, PC A06/MF A01.

The document reports work in progress toward the evaluation of implementation and effects of market mechanisms for regulation of major stationary sources of air pollution. The first chapter introduces and synopsizes the report. The second chapter describes the context in which market mechanisms are being introduced. The third chapter discusses the underlying logic of various market mechanisms and an operating prototype of a market mechanism. The fourth chapter discusses potential effects of market mechanisms on air pollution regulation. The fifth chapter reports expectations associated with EPA's introduction of a prototype market mechanism offset policy. Chapter six describes the general direction of continuing work on this particular project.

24640 (PB—301234) **Impact of air quality control measures.** Zabinski, R.J.; Cohen, G.S.; Hartgen, D.T.; Hoyles, M.R.; Scheuernstuhl, G.J. (Transportation Research Board, Washington, DC (USA)). 1979. 37p. NTIS, PC A03/MF A01.

The 5 papers in this report deal with the following areas: New York State response to the mandates of the clean air act; simplified method for evaluation of control strategies for revision of state implementation plans; analysis of air quality sensitivity to development pattern changes and growth levels; travel and emissions impacts of transportation control measures; and exhaust emissions, fuel consumption, and traffic--relations derived from urban driving schedule data.

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

24641 (EMSL-LV—0539-33) **Soil profiles of mounds on plutonium-contaminated areas of the Nevada Test Range Complex.** Leavitt, V.D. (Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring and Support Lab.). Jan 1980. Contract EY-76-A-08-0539. 158p. Dep. NTIS, PC A08/MF A01.

This report describes soil profiles of the surface soils in mounds in two areas located on the Test Range Complex, Nye County, Nevada. Both areas have been the sites of aboveground nuclear safety tests. These areas are contaminated with plutonium and are the object of investigations regarding the movement of plutonium in the environment.

24642 (CONF-7910141—1) **Monitoring on rights-of-way and the National Biomonitoring Inventory.** Burgess, R.L.; Huber, E.E. (Oak Ridge National Lab., TN (USA)). [nd]. Contract W-7405-ENG-26. 10p. NTIS, PC A02/MF A01.

From 2. symposium on environmental concerns in rights of way management; Ann Arbor, MI, USA (16 Oct 1979).

Monitoring programs dealing with rights-of-way have been identified from the National Biomonitoring Inventory data base. Monitoring programs cover a wide variety of ecological concerns and geographical areas and occur along oil and gas pipelines, electric power transmission corridors, highways, and railroads. Programs are located from California to Connecticut and Alaska to Florida. Ecologically sensitive areas can be identified and mitigation measures considered during early stages of the route selection process and baseline inventories prepared for monitoring programs can be used for environmental impact assessment. The Biological Monitoring Inventory data base at Oak Ridge National Laboratory can provide a great deal of pertinent information for project planning, environmental assessment, and post-operational management. Examples of actual monitoring programs are presented for a variety of rights-of-way, including transmission corridors, highways, and pipelines. In addition, we have shown, both with hypothetical and concrete examples, how the Inventory can be used.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 24588, 24593, 24594, 24726

24643 (CONF-791090—7) **Regional ecological assessment approach to atmospheric deposition: effects on soil systems.** Klopatek, J.M.; Harris, W.F.; Olson, R.J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 34p. Dep. NTIS, PC A03/MF A01.

From Symposium on potential environmental and health effects of atmospheric sulfur deposition; Gatlinburg, TN, USA (14 Oct 1979).

A regional ecological overview of the potential effects of acid precipitation on soils is presented. Computer maps of soil pH, CEC, base saturation, and base content in the eastern United States are displayed using county level data. These maps are then overlain with a computer map of the hydrogen ion loading and resultant maps of acid sensitive and acid insensitive soils are presented. Of 1572 counties in the eastern US, only 117 are classified as being acid sensitive. A number of qualifications concerning the data and the implications for management are discussed.

24644 **Compartmentalization of ^{14}C-DDT in an experimental old-field plot.** Grau, B.; Peterie, T.J. (Ohio State Univ., Columbus). *Bull. Environ. Contam. Toxicol.;* **22**: No. 6, 846-853(Aug 1979).

Of the 2.81 x 10^6 ug DDT applied to the plot in June 1976, 2.58 x 10^6 ug (91.8%) were accounted for as of June 1977. Silk screens, ethylene glycol air samples, and run-off contained 40.57 x 10^{-3}%, 0.09 x 10^{-3}%, and 1.18 x 10^{-3}%, respectively of the DDT applied. Soil was the major sink for DDT in this study, with 91.8% of the applied DDT located there. Most of the remaining 8.2% was probably lost during the formulation and application of the ^{14}C-DDT granules, some were probably lost in organisms (mainly flying insects) leaving the plot, and some were accounted for by experimental error and error in the counting technique.

24645 **Review of the environmental impact of ground disposal of oil shale wastes.** Routson, R.C.; Wildung, R.E.; Bean, R.M. (Battelle Pacific Northwest Lab., Richland, WA). *J. Environ. Qual.;* **Contract EY-76-C-06-1830**: No. 1, 14-19(Jan 1979).

Waste disposal methods for the major types of extraction processes, the potential environmental impacts of waste disposal to the ground, mitigation of environmental effects, and further research needs of the oil shale industry are considered. Principal waste products of oil shale extraction constitute up to 125% of the original volume, and disposal may, therefore, affect vast land areas. Principal wastes scheduled for ground disposal include the waters produced during retorting and subsequently separated from the shale oil and the spent shales remaining after extraction. Retort waters contain relatively high concentrations of complex, soluble organic components and the spent shales contain potentially leachable salts and organic pyrolytic products. In addition, spent shales have erosion potential when disposed on the surface and considerable effort is being directed to shale management, emphasizing erosion control and shale as a growth medium, and revegetation methods for establishing salt- and drought-tolerant plant species.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 24628, 24629, 24630

24646 (RFP-ENV—79) **Annual environmental monitoring report, January-December 1979.** Howerton, R.D. (ed.). (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 10 Apr 1980. Contract AC04-76DP03533. 48p. Dep. NTIS, PC A03/MF A01.

This report documents the 1979 environmental surveillance program at the Rocky Flats Plant, as conducted by the Environmental Analysis Section of the Environmental Sciences Branch. Sample analyses are performed by the Health, Safety, and Environmental Laboratories of the Health, Safety, and Environment Department and by the General Laboratory of the Quality Engineering and Control Department. The report includes an evaluation of Plant compliance with all appropriate guides, limits, and standards. Potential public radiation dose commitments were calculated from average radionuclide concentrations measured at the Plant property boundaries and in surrounding communities.

SOIL

REFER ALSO TO CITATION(S) 23729, 23740, 24641, 24655

24647 (LA—8221) **Studies of long-term ecological effects of exposure to uranium V.** White, G.C.; Simpson, J.C.; Bostick, K.V. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 26p. (AFATL-TR—79-101). Dep. NTIS, PC A03/MF A01.

Research performed by the Los Alamos Scientific Laboratory (LASL) for the Air Force Armament Laboratory, Eglin Air Force Base, Florida, is reported. A statistical technique called kriging was used to analyze the uranium concentrations in surface soil at E-F Site (LASL). Kriging provided a much more realistic contour surface for uranium concentrations than either a polynomial trend analysis or contouring the original data. The major advantages of kriging are that a measure of the uncertainty of the contoured surface is provided, and that the nonparametric nature of the method allows very irregular surfaces to be fitted. A function relating the uranium counting efficiency of the phoswich portable survey instrument to ambient temperature (10 to 30°C) was developed. Counting efficiency is maximum at approximately 10°C and declines significantly at higher sample temperatures. The counting efficiency of the phoswich was not affected by soil moisture or relative humidity.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 23507, 23516, 23517, 23525, 23530, 23697, 23730, 23739, 23741, 23742, 23745, 23746

24648 (PB—299689) **Boone County field site interim report. Test cells 2A, 2B, 2C, and 2D. Interim report August 1972-December 1976.** Wigh, R.J. (Regional Services Corp., Inc., Columbus, IN (USA)). Jul 1979. 204p. NTIS, PC A10/MF A01.

Sanitary landfills presently play a significant role in the disposal of solid wastes, and they will probably continue to do so in many areas because of their economic advantages over other methods. However, justifiable concern exists about the environmental effects of sanitary landfills. The research project described here was undertaken to provide a better understanding of the processes that occur within a sanitary landfill and the related environmental effects. The initial field-scale test cell was completed in June 1971 and has been monitored since then for temperature, gas composition, settlement, and leachate quantity and characteristics. Four additional cells (2A, 2B, 2C, and 2D) were constructed during August 1972. One of these was field-scale (2D), and the others were small-scale cells that simulated the large cell for the purpose of performance comparison. Water input to the cells was controlled, and all cells were monitored for temperature, gas composition, settlement, and leachate quantity and characteristics.

24649 (PB—300525) **National environmental models of agricultural policy, land use and water quality. Progress report no. 4.** Madsen, H.C.; Heady, E.O. (Iowa State Univ. of Science and Technology, Ames (USA). Center for Agricultural and Rural Development). May 1974. 59p. NTIS, PC A04/MF A01.

Extension of the Soil Loss Control Model (SLCM) to Models I and II is reported. These models are designed to simulate national and regional impacts of soil loss restriction. Model I was developed to satisfy a majority of users and to have lower solution costs than SLCM. This involved regional delineation (using a 90- region model instead of 223 for SLCM), restructuring the soil loss parameters, rotations, and other modifications learned from work with SLCM. Ten solutions for the nation and regions have been completed with Model I, emphasizing land use, water use, agricultural technology, soil loss, and export impacts. A special model was developed to investigate impacts of environmental and resource restraints in individual states. In response to the National Program Assessment Committee's production for the Second National Assessment, work was begun on Model II, on 105-region model. Model II differs principally from Model I in that the former incorporates sediment and transport ratios, evaluates livestock waste controls, and takes into consideration urban and other uses of agricultural lands and erosion rates. Future work is outlined. An extensive appendix is included.

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 24024, 24025, 24026, 24642

24650 (BNL—27406) **Shelf-sea ecosystems.** Walsh, J.J. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 75p. NTIS, PC A04/MF A01.

An analysis of the food chain dynamics of the Oregon, Alaskan, and New York shelves is made with respect to differences in physical forcing of these ecosystems. The world's shelves are 10% of the area of the ocean, yield 99% of the world's fish catch, and may be a major sink in the global CO_2 budget.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 23526, 23528, 23530, 23607, 23608, 23609, 23660, 23661, 24008, 24317, 24485, 24588, 24593, 24594, 24621, 24644, 24660, 24765, 24768, 24770, 24775

24651 (CONF-791059—8) **Room temperature phosphorimetry for the analysis of environmental systems.** Vo-Dinh, T.; Gammage, R.B. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

From 4. international symposium on polynuclear aromatic hydrocarbons; Columbus, OH, USA (2 Oct 1979).

Room Temperature Phosphorimetry (RTP) is a relatively new technique gaining increasing interest among analytical spectroscopists. This technique is based on the detection of the phosphorescence emitted from organic compounds adsorbed on solid substrates at room temperature. In this laboratory, analytical applications of the RTP process have received special attention. Extensive efforts are devoted to developing the usefulness of RTP as a rapid, simple tool for monitoring trace organic pollutants. This paper presents some recent developments and illustrates some practical applications of the technique in the characterization of polynuclear aromatic compounds in synfuel-derived samples.

24652 (PB—300670) **Environmental assessment of coal cleaning processes; master test plan. Final report June 1977-January 1979.** Tolle, D.A.; Neuendorf, D.W.; Van Voris, P. (Battelle Columbus Labs., OH (USA)). Feb 1979. Contract EPA-68-02-2163. 77p. NTIS, PC A05/MF A01.

The report gives a master test plan, presenting the objectives and general structure of a field testing program designed for an environmental source assessment of coal cleaning processes. The report, to be used to prepare test plans for individual coal cleaning sites, reflects the common thread running through a series of various sites. It includes the background and objectives of Battelle's overall program for EPA, entitled 'Environmental Assessment of Coal Cleaning Processes'. The report emphasizes the philosophy of the field testing program and the elements of sampling and sample analysis which are common to all test sites. Coal cleaning facilities to be tested in the 10 site categories will be evaluated at three sampling and analytical levels. Level 1 tests identify problem areas that are assessed by the more rigorous Level 2 tests. Level 3 involves long-term monitoring of 'key' indicator parameters which have been identified in the environmentally hazardous streams tested by Level 2 techniques. Environmental source assessments will: systematically evaluate the physical, chemical, and biological characteristics of selected process streams and all effluent streams; predict the potential effects of those streams on the environment; rank the streams according to their relative biological toxicity; and identify areas requiring further research and development.

24653 **Strategies for marine pollution monitoring.** Goldberg, E.D. (ed.). New York, NY; John Wiley and Sons (1976). 319p.

Methods for the monitoring and analysis of seawater and aquatic ecosystems for detection of environmental pollutants are covered in this book. Separate abstracts are included for items in scope for this data base. (DC)

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 24628, 24629, 24634, 24646

WATER

24654 (UCID—18652) **BIODOSE: a code for predicting the dose to man from radionuclides released from underground nuclear waste repositories.** Bonner, N.A.; Ng, Y.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1980. Contract W-7405-ENG-26. 127p. NTIS, PC A07/MF A01.

The BIODOSE computer program simulates the environmental transport of radionuclides released to surface water and predicts the resulting dosage to humans. This report describes the program and discusses its use in the evaluation of nuclear waste repositories. The methods used to estimate dose are examined critically, and the most important parameters in each stage of the calculations are identified as an aid in planning for measurements in the field. Dose predictions from releases of nuclear waste to a large northwestern river (the baseline river) are presented to point out the nuclides, compartments and pathways that contribute most to the hazard as a function of waste storage time. Predictions for five other water systems are presented to identify the most important system parameters that determine the concentrations of individual nuclides in compartments and the resultant dose. The uncertainties in the biological parameters for dose prediction are identified, and changes in current values are suggested. Various ways of reporting dose estimates for radiological safety assessments are discussed. Additional work needed to improve the dose predictions from BIODOSE and specific areas and steps to improve our capabilities to assess the environmental transport of nuclides released from nuclear waste repositories and the resultant dose to man are suggested.

24655 **Distribution of ^{239} ^{240}Pu, ^{238}Pu, and ^{137}Cs in various particle size classes of Lake Michigan sediments.** Alberts, J.J.; Muller, R.N. (Savannah River Ecology Lab., Aiken, SC). Contract EY-76-C-09-0819. *J. Environ. Qual.;* 8: No. 1, 20-22(Jan 1979).

The distribution of ^{238}Pu, ^{239} ^{240}Pu, and ^{137}Cs was determined in sediment samples from Lake Michigan which had been separated into various particle size classes by an elutriation technique. Within the range of size classes studied the distribution of these isotopes are not a function of particle size, but rather have a constant concentration. In addition, calculations of ratios of ^{239} ^{240}Pu and ^{137}Cs concentrations on particles to their concentration in the overlying water showed: the ratios are similar for both plutonium and cesium ($\sim 10^5$); and the ratios do not vary with particle size for either element.

AQUATIC ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 23862

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 24761

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 23527, 23659, 23735, 23754, 24761

24656 (PB—300280) **Marine fisheries review, volume 41, number 3, March 1979.** Hobart, W. (National Marine Fisheries Service, Seattle, WA (USA)). Mar 1979. 49p. NTIS, PC A03/MF A01.

In addition to its regular sections this issue contains the following articles: A review of survival rates of fish eggs and larvae in relation to impact assessments; Geographic and monthly variation in composition of oysters, Crassostrea virginica; and Floating horizontal and vertical raceways used in freshwater and estuarine culture of Juvenile Salmon, Oncorhynchus spp.

24657 (PB—300495) **Water development in Wyoming: a study of resident attitudes, 1971. Completion report.** Parker, J.C.; Phillips, C.; Ferguson, S.E. (Wyoming Univ., Laramie (USA). Water Resources Research Inst.). 1979. Contract DI-14-31-0001-3551. 49p. NTIS, PC A03/MF A01.

The attitudes of Wyoming residents toward water resource development and their priorities for water use were surveyed in 1971. The survey covered general priorities, specific trade-offs between various development options, and potential problems. The 560 individuals responding to the questionnaire represented a full range of occupations, educational backgrounds, and income levels; every county in the state was represented, including residents of communities of all sizes and of rural areas. Responses are presented and discussed by both absolute and relative frequency. Agricultural use is the concept of water development ranked most important by one-third of the residents surveyed. Wyoming residents generally feel tha the state's streams have 'some' pollution, and they ranked planning and development most important of the water problems that the state will face in the near future.

24658 (PB—300815) **The Yampa River Basin, Colorado and Wyoming--a preview to expanded coal-resource development and its impacts on regional water resources. Water-resources investigations (final).** Steele, T.D.; Bauer, D.P.; Wentz, D.A.; Warner, J.W. (Geological Survey, Lakewood, CO (USA). Water Resources Div.). Sep 1979. 144p. NTIS, PC A07/MF A01.

Expanded coal production and conversion in the Yampa River basin, Colorado and Wyoming, may have substantial impacts on water resources, environmental amenities, and socioeconomic conditions. Preliminary results of a 3-year basin assessment by the U.S. Geological Survey are given for evaluation of surface- and ground-water resources using available data, modeling analysis of waste-load capacity of a Yampa River reach affected by municipal wastewater-treatment plant effluents, and semiquantitative descriptions of ambient air- and water-quality conditions. Aspects discussed are possible constraints on proposed development due to basin compacts and laws regulating water resources, possible changes in environmental-control regulations, and policies on energy-resource leasing and land use that will influence regional economic development.

24659 (PB—300828) **The biology of salt wells creek and its tributaries, southwestern Wyoming. Water-resources investigations.** Engelke, M.J. Jr. (Geological Survey, Cheyenne, WY (USA). Water Resources Div.). 1978. 99p. NTIS, PC A05/MF A01.

A description of biological communities in Salt Wells Creek, a plains stream in the Green River Basin of Wyoming, is presented. The description includes population distribution patterns, community edge effects, the food pyramid, and nutrition (trophic) levels between various types of plants and animals. Both algae and stream invertebrates were studied. Salt Wells Creek is a low-nutrient concentration system in the plains of southwestern Wyoming. The observed sources of phytoplankton were springs, stock ponds, and the periphytic algae dislodged from the substrate. During high flows, green and blue-green algae were dominant. During low flows, the streams became pondlike with intermittent flow, and were dominated by diatoms. Principle diatom genera were Navicula, Nitzschia, Surirella, and Gomphonema. Seasonal succession of community development occurred in periphyton and benthic invertebrates. The amphipod, Gammarus (scud), is the principal benthic orgaism found in the basin. Trichoptera were the second most abundant benthic invertebrate. A conceptual model of the aquatic biology and its relations to water chemistry in a plains stream is presented.

24660 (PB—300843) **Effects of seepage from fly-ash settling ponds and construction dewatering on ground-water levels in the Cowles Unit, Indiana Dunes National Lakeshore, Indiana. Water-resources investigations (final) 1976-77.** Meyer, W.; Tucci, P. (Geological Survey, Indianapolis, IN (USA). Water Resources Div.). Jan 1979. 103p. NTIS, PC A06/MF A01.

Part of the Indiana Dunes National Lakeshore shares a common boundary with the Northern Indiana Public Service Company (NIPSCO). This area is underlain by unconsolidated deposits approximately 180 feet thick. NIPSCO accumulates fly ash from the burning of coal in electric-power generating units in settling ponds. Seepage from the ponds has raised ground-water levels above natural levels approximately 15 feet under the ponds and more than 10 feet within the Lakeshore. NIPSCO is presently (1977) constructing a nuclear powerplant, and construction activities include pumping ground water to dewater the construction site. The company has installed a slurry wall around the site to prevent lowering of groundwater levels within the Lakeshore. Plans call for continuous pumping through at least December 1979. A multilayered digital flow model was constructed to simulate the ground-water system. The model was used to demonstrate the effects of seepage from the fly-ash ponds on ground-water levels.

24661 (PB—301068) **Lake Powell effect on Colorado River Basin water supply and environment (Lake Powell Research Project interim report).** Jacoby, G.C. Jr. (California Univ., Los Angeles (USA). Inst. of Geophysics and Planetary Physics). May 1975. 36p. NTIS, PC A03/MF A01.

This report is concerned with the effect of Lake Powell, a multi-purpose reservoir providing water storage, hydroelectric power, and recreation in southeastern Utah. Located in the Colorado River Basin, its creation has inundated Glen Canyon and increased assess to the remaining portions. Storage in Lake Powell gives major control over the Upper Basin in surface-water sources. Development of the Upper Basin and extra-basinal pressure for exportable water, food, fiber, and energy will increase consumptive use. Control coupled with increased consumptive use will have water supply and environmental consequences throughout the entire

Colorado River Basin of much greater significance than local effects. A decade of rapid consumptive use development in the Upper Basin would use up the surface-water resource and sharply curtail growth.

REGULATIONS

REFER ALSO TO CITATION(S) 24637

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 23602, 23603, 23604, 23776, 24027, 24038, 24177, 24188, 24195, 24637, 24639, 24657, 24658

24662 (ALO—80) **CANVEY: the reaction of a community exposed to substantial risks.** Cave, L. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). Apr 1980. Contract EY-76-C-04-0789;ET-78-S-04-5450. 13p. (UCLA-ENG—7967). NTIS, PC A02/MF A01.

There have been numerous studies which have had as their objective the determination of societal attitudes to risk. The case of the Canvey Island population appears to offer an almost unique opportunity to study the reaction of a large community (some 33,000 persons) exposed to risks from local industries which, as estimated by the regulatory body concerned, are much larger than the average for the rest of the public in the UK. In order to provide further perspective on public reaction to large risks, in conditions where many of the community do not perceive themselves to benefit from the activities which generate the risk, it is worthwhile to record the reaction of the islanders to the situation.

24663 (CONF-800474—1) **Modeling the prospects for climatic change: current state-of-the-art and implications.** Kellogg, W.M. (Aspen Inst. for Humanistic Studies, Boulder, CO (USA); National Center for Atmospheric Research, Boulder, CO (USA)). 4 Apr 1980. Contract AC02-79EV10281. 43p. NTIS, PC A03/MF A01.

From Economic methodologies for climate change; Ft Lauderdale, FL, USA (24 Apr 1980).

It has been increasingly suggested that the world's climate is going to change in the next several decades, primarily as a result of anthropogenic perturbations to the global carbon cycle brought about by fossil fuel burning and large-scale deforestation. In order to cope with these future climatic changes, it is necessary that tools be developed to predict how complex systems respond to a given change of conditions. This report summarizes the status of our ability to model the planetary system that determines the climate. (ACR)

24664 (CONF-800475—1) **Toward a political analysis of the consequences of a world climate change produced by increasing atmospheric carbon dioxide.** Schware, R. (Aspen Inst. for Humanistic Studies, Boulder, CO (USA)). 1980. Contract AC02-79EV-10281. 25p. NTIS, PC A02/MF A01.

From Southwestern Political Science Association annual meeting; Houston, TX, USA (2 Apr 1980).

It was Hegel's extraordinarily deep and perceptive insight that mankind is caught up in a drama that cannot be fully understood until it has been played out. The owl of Minewa spreads its wings only with the falling of the dusk. On the more hopeful side is the fact that, although we cannot know the consequences of future interactions between climate and society, we can begin to work toward political solutions and gird ourselves for ominous trends that are now coming into view. The purpose of this paper is to identify one such trend, namely the increase of atmospheric temperatures due to increased carbon dioxide (CO_2) and lay some initial groundwork for political research related to climate-societal interactions.

24665 (PB—301221) **Boomtown impacts of energy development in the Lake Powell Region (Lake Powell Research Project).** Ives, B.C.; Schulze, W.D.; Brookshire, D.S. (New Mexico Univ., Albuquerque (USA). Resources Economics Group). Sep 1976. 85p. NTIS, PC A05/MF A01.

This report quantifies the economic impact of past energy-development activity in the western states region and examines projected boomtown impacts of the proposed Kaiparowits project, emphasizing the effects of local economic benefits. A model of a boomtown economy based on primary data collected from Page, Arizona and optimal strategies for investment in boomtown communities are developed. The need for front-end capital traditionally in short supply because of institutional constraints in the money market is illustrated in theory. Higher interest rates are shown to cause the construction booms associated with large energy projects to be briefer and more intense and productivity to drop during the course of the boom. The near isomorphism between economic cycles in small isolated communities and the pattern of construction labor associated with large energy projects is illustrated using an input-output model of the Page area economy. Regional planning and new towns for energy development are discussed.

ASSESSMENT OF ENERGY TECHNOLOGIES

24666 (PB—301313) **Oxidation techniques in Drinking water treatment. drinking water pilot project. Report IIa. Advanced treatment technology. Final report.** Kuehn, Ing.W.; Sontheimer, H. (Karlsruhe Univ. (TH) (Germany, F.R.). Engler-Bunte Inst.). 1979. Contract EPA-68-01-3169. 771p. NTIS, PC A99/MF A01.

This report is a compilation of the papers presented at the EPA sponsored international conference held in Karlsruhe, Federal Republic of Germany, in September 1978. It discusses the problem of controlling health hazardous organo-chloro compounds resulting form traditional chlorination of drinking water and the oxidation techniques that can potentially remedy that problem. These include (1) changing or eliminating points of chlorination in conjunction with modification of other treatment processes, (2) ozonation for different durations and conditions at different points of conventional treatment, (3) biological oxidation in slow filter media (e.g., sand, activated carbon) and within the ground (riverbank filtration) and (4) use of chlorine dioxide, ultraviolet light and hydrogen peroxide, and potassium permanganate. These other oxidants, however, may introduce other chemicals of currently unknown health risk. Removal of other contaminants (e.g., bacteria, virus, ammonia, iron, manganese, trace metals) are also discussed.

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 23723, 23724, 23725, 23726, 23727

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

24667 (DOE/EV/02472—6) **Study of mathematical models of mutation and selection in multi-locus systems. Annual progress report, April 1, 1979-March 31, 1980.** Lewontin, R.C. (Harvard Univ., Cambridge, MA (USA). Museum of Comparative Zoology). 1980. Contract AC02-76EV02472. 10p. NTIS, PC A02/MF A01.

During the past year, research has been devoted to two topics with principal results as follows: (1) an analytic and computer study was carried out of the growth of a population like the human population, which has age distributed mortality and fecundity, but for which the rates of birth and death are varying from period to period in time. The entries in the Leslie Matrix were considered to vary by a Markov process. The result is that although the expectation of the population size may grow, the numbers may decrease to zero with high probability and that, in general, the population size at time t depends upon the logarithm of growth rates, and ln λ/sub t/ is asymptotically normally distributed; and (2) numerical studies were undertaken of 2 locus genetic models with asymmetric fitness matrices created by perturbing the parameters of symmetric fitness matrices where solutions are known analytically. The general results are that linkage equilibrium solutions do not exist at all for such asymmetric models, that the value of D at loose linkage is about the order of the asymmetry and that for asymmetric models there is a critical value of recombination below which new equilibria come into existence beside the one that exists for all r.

24668 (PNL—3081) **Anaktuvuk Pass, Alaska village census.** Hanson, W.C. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1980. Contract EY-76-C-06-1830. 20p. Dep. NTIS, PC A02/MF A01.

This report represents an updating of similar censuses conducted at Anaktuvuk Pass, Alaska, during November 1969, September 1972, June 1975, and August 1978. During the initial years of 1962-1964 in the Alaskan radiation ecology studies, centered at Anaktuvuk Pass, it became apparent that various age groups among the residents showed important differences in ^{137}Cs body burdens and that a permanent record of the birth dates and locations would be a necessity. These vital data are the sole record of birth dates and places of several Anaktuvuk Pass people and have proved helpful to them in many contexts. The information has been readily provided and periodically updated with the full knowledge and cooperation of

the people. This report must be considered an interim record because the composition of the village resident structure constantly changes; however, the information is as current and as accurate as possible. It is presented here for the interest of the people of Anaktuvuk Pass and the use of scientists and lay persons who recognize the unique qualities of the nunamiut and wish to know more about these people.

24669 Size and pattern of simulated forest stands. Shugart, H.H.; West, D.C. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *For. Sci.;* **25**: No. 1, 120-122(1979).

The dynamics of a deciduous forest stand growth model are examined with regard to variation in the simulated plot size. As the plot size in the model is decreased, the importance of the shading interaction is diminished and the effects of root competition is increased, preventing any tree from reaching its maximal size. As the plot size increase, root competition diminishes and shading or canopy interactions dominate, eliminating shade intolerant species. If the plot size is too large then the death of a single tree is insignificant in the canopy dynamics and gap phase replacement does not occur. The contrasting effects of plot size on the importance of root and crown competition provides a quantitative basis for identifying the size of a forest stand based on community level dynamics.

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 24492, 24704, 24706, 24707, 24708, 24710, 24714, 24718, 24719, 24737, 24738, 24743, 24762, 24763

24670 (DOE/EV/03221—65) Quaternay structure and spin state of human fetal methemoglobin. Progress report, September 1, 1979-July 1, 1980. Chevion, M.; Ilan, Y.A.; Navok, T.; Czapski, G. (Hebrew Univ., Jerusalem (Israel)). 1980. Contract AC02-76EV03221. 24p. NTIS, PC A02/MF A01.

The transition between the high spin form of methemoglobin A was also studied by low-temperature EPR spectroscopy both in the absence and in the presence of IHP. The results showed a pK = 8.2 for this transition for the stripped protein, while in the presence of IHP the pK is shifted to about 8.5.

24671 Aryl hydrocarbon hydroxylase: degradation of product due to contaminant in acetone. Haugen, D.A. (Argonne National Lab., IL). *Anal. Biochem.;* **103**: No. 1, 77-80(15 Mar 1980).

A contaminant present in reagent grade acetone causes degradation of fluorescent phenolic metabolites of benzo(a)pyrene as measured in the aryl hydrocarbon hydroxylase assay. Although the contaminant was not identified, its properties suggest that it is a relatively volatile organic material, possibly an oxidizing agent. The acetone may be readily purified by distillation.

24672 Assay of adenosine 3',5' cyclic monophosphate by stimulation of protein kinase: a method not involving radioactivity. Handa, A.K.; Bressan, R.A. (Michigan State Univ., East Lansing). Contract EY-76-C-02-1338. *Anal. Biochem.;* **102**: No. 2, 332-339(1 Mar 1980).

In order to meet a need for a cAMP assay which is not subject to interference by compounds in plant extracts, and which is suitable for use on occasions separated by many ^{32}P half-lives, an assay based on cAMP-dependent protein kinase has been developed which does not require the use of [γ-^{32}P]ATP. Instead of measuring the cAMP-stimulated increase in the rate of transfer of [γ-^{32}P] phosphate from [γ-^{32}P]ATP to protein, the rate of loss of ATP from the reaction mixture is determined. The ATP remaining after the protein kinase reaction is assayed by ATP-dependent chemiluminescence of the firefly luciferin-luciferase system. Under conditions of the protein kinase reaction in which a readily measurable decrease in ATP concentration occurs, the logarithm of the concentration of ATP decreases in proportion to the cAMP concentration, i.e., the reaction can be described by the equation: [ATP] = [ATP]$_0$ e/sup -[cAMP]kt/. The assay based on this relationship can detect less than 1 pmol of cAMP. The levels of cAMP found with this assay after partial purification of the cAMP from rat tissue, algal cells, and the media in which the cells were grown agreed with measurements made by the cAMP binding-competition assay of Gilman, and the protein kinase stimulation assay based on transfer of [^{32}P] phosphate from [γ-^{32}P]ATP to protein. All of the enzymes and chemicals required for the assay of cAMP by protein kinase catalyzed loss of ATP can be stored frozen for months, making the assay suitable for occasional use.

24673 Analytical techniques for cell fractions. XXVII. Use of heart proteins as reference standards in two-dimensional electrophoresis. Giometti, C.S.; Anderson, N.G.; Tollaksen, S.L.; Edwards, J.J.; Anderson, N.L. (Argonne National Lab., IL). *Anal. Biochem.;* **102**: No. 1, 47-58(Feb 1980).

The preparation and use of rat heart whole homogenate as a standard for the sodium dodecyl sulfate (SDS) electrophoresis dimension of two-dimensional electrophoresis is described. By including the rat heart homogenate in the agarose overlay used to hold an isofocusing gel (first dimension) in contact with a slab gel (second dimension), 80 horizontal lines can be superimposed on a two-dimensional electrophoresis pattern. Such an internal standard is useful as a reference marker for the intercomparison of many gels and also, when calibrated, can be used to determine the approximate molecular weight of proteins.

24674 Analytical techniques for cell fractions. Willard, K.E.; Giometti, C.S.; Anderson, N.L.; O'Connor, T.E.; Anderson, N.G. (Argonne National Lab., IL). W-31-109-ENG-38. *Anal. Biochem.;* **100**: No. 2, 289-298(Dec 1979).

The ISO-DALT system of two-dimensional electrophoresis allows high-resolution separations of proteins and protein subunits. However, the conventional isoelectric focusing employed in this system does not give satisfactory resolution of the more basic proteins, such as histones. The BASO-DALT system was designed to obtain improved resolution of these basic proteins in the first dimension. In this system, phosphatidyl choline is used as the solubilization agent, and allows resolution of many low molecular weight basic proteins that were not seen with more conventional detergents. Using the BASO-DALT system, Novikoff hepatoma chromosomal proteins have been analyzed, and the five histones identified.

24675 Effect of the composition of sodium dodecyl sulfate preparations on the renaturation of enzymes after polyacrylamide gel electrophoresis. Lacks, S.A.; Springhorn, S.S.; Rosenthal, A.L. (Brookhaven National Lab., Upton, NY). *Anal. Biochem.;* **100**: No. 2, 357-363(Dec 1979).

The extent of renaturation of enzymes after polyacrylamide gel electrophoresis in the presence of sodium dodecyl sulfate depended on the source of the detergent. Analysis of commercial preparations of sodium dodecyl sulfate revealed appreciable amounts of tetradecyl and hexadecyl sulfates in some preparations. Inhibition of renaturation was correlated with the amount of hexadecyl sulfate and, to a much lesser extent, of tetradecyl sulfate present. The higher alkyl sulfates appeared to bind more tenaciously to proteins in the gel. More extensive washing was required to remove them than to remove dodecyl sulfate, and they were inhibitory to enzyme activity at lower detergent concentrations. A system is described for gas chromatographic analysis of alkyl sulfates containing chains of 10 to 16 carbon atoms in length.

24676 Muscle protein analysis. I. High-resolution two-dimensional electrophoresis of skeletal muscle proteins for analysis of small biopsy samples. Giometti, C.S.; Anderson, N.G.; Anderson, N.L. (Argonne National Lab., IL). *Clin. Chem.;* **25**: No. 11, 1877-1884(Nov 1979).

A clinically useful method for high-resolution two-dimensional electrophoretic analysis of small (5 to 10 mg) human muscle biopsy samples with sufficient resolution to resolve the major contractile proteins and enzymes is being developed. Using rabbit psoas muscle as a model, we describe methods for sample preparation and two-dimensional electrophoresis. Basic proteins, which appear as streaks when conventional isoelectric focusing is used in the first dimension, are resolved through a modification of the nonequilibrium pH gradient electrophoresis method [Cell 12, 1133 (1977)]. In the two-dimensional patterns obtained from rabbit muscle, the components of 10 enzymes and of myosin, actin, tropomyosin, and troponin are identified. These patterns indicate charge heterogeneity in a large fraction of the proteins. Comparison of rabbit and normal human muscle patterns shows many similarities, but much additional work is required to confirm identifications. We conclude that analysis of small biopsy samples is feasible, but that all aspects of human sample acquisition, storage (when necessary), and preparation require thorough study before the method becomes routine in human muscle research and, ultimately, in the diagnosis of some muscle diseases.

24677 Photoreversible absorbance changes in solutions of allophycocyanin purified from Fremyella diplosiphon: temperature dependence and quantum efficiency. Ohad, I. (Harvard Univ., Cambridge, MA); Clayton, R.K.; Bogorad, L. *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 11, 5655-5659(Nov 1979).

Preparations of allophycocyanin isolated from the alga Fremyella diplosiphon show light-induced optical absorbance changes that suggest the presence of a photoconvertible component similar to the algal pigments described by J. Scheibe [(1972) Science 176, 1037-1039]. At pH < 4 the allophycocyanin has an absorption maximum at 620 nm. Red illumination causes a loss of absorbance in the red, centered at 620 nm, and subsequent green illumination restores the lost absorbance. We have studied this photoconversion at temperatures between 200°K and 307°K, analyzing the results in terms of photostationary states established under red (640 nm) and green (550 nm) light. As the temperature was lowered to 260°K, the state P/sub r/ became progressively favored; the reaction P/sub r/ → P/sub g/ induced by red light was attenuated but the reaction P/sub g/ → P/sub r/ induced by green light was not. Decreasing the temperature from 260°K to 200°K had no further effect. Two distinct and simple models can account for this curious temperature dependence. By

analyzing the kinetic and steady-state data, with reasonable estimates of the molar extinction coefficients of P/sub r/ and P/sub g/, we computed quantum efficiencies greater than 15% for the photoconversion at 300°K. We deduced that a conversion of all P/sub r/ to all P/sub g/ should produce a fractional absorbance change ΔA/A at 620 nm equal to 0.1. If the chromatic adaptation response of intact F. diplosiphon shows the unusual temperature dependence reported here, the system P/sub r/ ⇌ P/sub g/ will be implicated in mediating this response.

24678 Triplet states in photosystem I of spinach chloroplasts and subchloroplast particles. Frank, H.A.; McLean, M.B.; Sauer, K. (Lawrence Berkeley Lab., CA). *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 10, 5124-5128(Oct 1979).

We report light-induced electron paramagnetic resonance triplet spectra from samples of chloroplasts or digitonin photosystem I particles that depend upon the dark redox state of the bound acceptors of photosystem I. If the reaction centers are prepared in the redox state P-700 A X^- Fd/sub B/$^-$ Fd/sub A/$^-$, then upon illumination at 11K we observe a polarized chlorophyll triplet species which we interpret as arising from radical pair recombination between P-700$^+$ and A^-. This chlorophyll triplet is apparently the analog of the P/sub R/ state of photosynthetic bacteria [Parson, W.W. and Cogdell, R.J. (1975) Biochem. Biophys. Acta 416, 105-149]. If the reaction centers are prepared in the dark redox state P-700 A X Fd/sub B/$^-$ Fd/sub A/$^-$, then upon illumination at 11K we observe a different triplet species of uncertain origin, possibly pheophytin or carotenoid. This species is closely associated with the photosystem I reaction center and it traps excitation when P-700 is oxidized.

24679 Interactions of 4-nitroquinoline 1-oxide with deoxyribodinucleotides. Winkle, S.A.; Tinoco, I. Jr. (Univ. of California, Berkeley). Contract W-7405-ENG-48. *Biochemistry;* **18**: No. 18, 3833-3839(4 Sep 1979).

The interactions of 4-nitroquinoline 1-oxide (NQO), a potent mutagen and carcinogen, with several self- and non-self-complementary deoxydinucleotides were probed by using absorption spectra of the charge transfer bands and ^1H and ^{13}C NMR spectra. Absorption spectra were analyzed by using Benesi-Hildebrand-type equations to yield stoichiometries and equilibrium constants of complex formation. Non-self-complementary dimers from weak 1:1 complexes [dpTpG:NQO,K(25°C) = 22 MA^{-1}] while self-complementary dimers form strong 2:1 complexes [$(dpCpG)_2$:NQO,K(25°C) = 2.2 x 10^4 M^{-2}]. A mixture of dpTpG and dpCpA with NQO gives a 2:1 complex [dpTpG:NQO:dpCpA,K(25°C) = 8.6 x 10^3 M^{-2}]. Analyses of the chnges in ^{13}C and ^1H NMR chemical shifts with complex formation gave approximate orientations for the intercalation of NQO with self-complementary dimer minihelixes. In the $(dpCpG)_2$:NQO and $(dpGpC)_2$:NQO complexes, the NO_2 group of NQO probably lies in the major grove and the NO_2, NO containing NQO ring is stacked near th purine imidazole ring. In the $(dpTpA)_2$:NQO and $(dpApT)_2$NWO complexes, the NO_2 seems to project into the minor grove and the NQO benzenoid ring is over the purine imidazole ring.

24680 Ligated chlorophyll cation radicals: their function in photosystem II of plant photosynthesis. Davis, M.S.; Forman, A.; Fajer, J. (Brookhaven National Lab., Upton, NY). *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 9, 4170-4174(Sep 1979).

Magnesium tetraphenylchlorin, a synthetic model for chlorophyll, exhibits significant variations in the unpaired spin densities of its cation radicals with concomitant changes in oxidation potentials as a function of solvent and axial ligand. Similar effects are observed for chlorophyll (Chl)a and its cation radicals. Oxidation potentials for Chl → Chl$^+$ as high as +0.9 V (against a normal hydrogen electrode) are observed in nonaqueous solvent, with linewidths of the electron spin resonance signals of monomeric Chl$^+$ ranging between 9.2 and 7.8 G in solution. These changes in electronic configuration and ease of oxidation are attributed to mixing of two nearly degenerate ground states of the radicals theoretically predicted by molecular orbital calculations. Comparison of the properties of chlorophyll in vitro with the optical, redox, and magnetic characteristics attributed to P-680, the primary donor of photosystem II which mediates oxygen evolution in plant photosynthesis, leads us to suggest that P-680 may be a ligated chlorophyll monomer whose function as a phototrap is determined by interactions with its (protein) environment.

24681 Ligated chlorophyll cation radicals: their function in photosystem II of plant photosynthesis. Davis, M.S.; Forman, A.; Fajer, J. (Brookhaven National Lab., Upton, NY). *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 9, 4170-4174(Sep 1979).

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24682 Photooxidation of antenna bacteriochlorophyll in chromatophores from carotenoidless mutant Rhodopseudomonas sphaeroides and the attendant loss of dimeric exciton interaction. Rafferty, C.N. (Cornell Univ., Ithaca, NY); Bolt, J.; Sauer, K.; Clayton, R.K. *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 9, 4429-4432(Sep 1979).

Intense continuous illumination of purified chromatophores from carotenoidless mutant Rhodopseudomonas sphaeroides results in progressive photooxidative loss of the near infrared absorption band near 860 nm assigned to antenna bacteriochlorophyll. The quantum yield of this reaction is low, approximately 1.7 x 10^{-5}. The loss in near infrared absorption is accompanied by a proportional shift in the absorption maximum to shorter wavelengths. The double circular dichroism feature in the near infrared decreases at a faster rate than does the absorbance. These results are explained by a model in which the antenna bacteriochlorophyll, initially associated as dimers (λ/sub max/ = 860.2 nm), is progressively converted to the monomeric state (λ/sub max/ = 851.9 nm). The wavelength shift is attributed to disruption of exciton coupling in the dimer. Acetone/methanol extraction indicates that the maximum molar extinction coefficients of the dimer and monomer do not differ by more than 4%. The occurrence of an absorption maximum at 852 nm for monomeric bacteriochlorophyll in a protein complex demonstrates that it is not necessary to invoke aggregation of the chromophores as the origin of the shift from 770 nm in typical organic solvents.

24683 Chromatin fractionation procedure that yields nucleosomes containing near-stoichiometric amounts of high mobility group nonhistone chromosomal proteins. Jackson, J.B.; Pollock, J.M. Jr.; Rill, R.L. (Florida State Univ., Tallahassee). *Biochemistry;* **18**: No. 17, 3739-2748(21 Aug 1979).

Initial results of an approach to the isolation of functionally active chromatin are described. Slight digestion of mouse myeloma nuclei at 0°C with micrococcal nuclease, followed by dialysis against near-physiological saline solution containing 1 mM Mg^{2+}, caused release of up to 17% of the nuclear DNA as soluble nucleoproteins. This soluble (S) fraction was relatively depleted in H1 histones and methylated DNA (5-methylcytosine) but highly enriched in RNA, single-stranded DNA, and nonhistone chromosomal proteins, particularly two species of the high mobility group identified as HMG 1 and HMG 2. The S fraction released most rapidly (6 to 8% of the total DNA) consisted mainly of mono- and small oligonucleosomes. The mononucleosomes appeared normal in terms of sedimentation behavior, DNA length, and content of histones H2A, H2B, H3, and H4, but lacked H1, and instead were associated with approximately stoichiometric amounts of HMG 1 and HMG 2. Studies using isolated, fluorescence-labeled, total mouse HMG proteins indicated that added HMG 1 and MHG 2 do not bind strongly to S-fraction nucleoproteins but that two smaller HMG species (probably HMG 14 and HMG 17) do not bind preferentially to S-fraction mono- and dinucleosomes. These results argue against artifactual redistribution of HMG 1 and HMG 2 during this fractionation but suggest caution in interpreting the distribution of smaller HMG proteins after digestion of chromatin. The potential relaionship of this soluble fraction to transcriptionally active chromatin is discussed.

24684 Transcription of yeast mitochondrial deoxyribonucleic acid. Jakovcic, S.; Hendler, F.; Halbreich, A.; Rabinowitz, M. Conctract EY-76-C-02--0069. *Biochemistry;* **18**: No. 15, 3200-3205(24 Jul 1979).

The transcription of yeast mitochondrial DNA (mtDNA) was examined by analysis of the kinetics of hybridization of mitochondrial RNA (mtRNA) with highly labeled mtDNA. The RNA was purified by guanidium chloride-CsCl equilibrium centrifugation, and the DNA was labeled in vitro by nick translation. Hybridization levels at apparent saturation were consistently about 35%. After preannealing of the RNA, it was found that approximately 30% hybridication remained. Hybridization levels were 10 to 15% at a R_0t (thr product of RNA concentration and time) of 1 mol s L^{-1} and reached apparent saturation at R_0t values of 10^2 to 10^3 mol sL^{-1}. Hybridization with a restriction fragment containing sequences of 21S rRNA also reached an apparent saturation level of about 35%, but hybridization was elevated at low R_0t values (10^{-1} mol s L^{-1}). Hybridization with separated strands of cloned EcoRI fragment 7-pMB9 recombinant DNA molecules was carried out. One DNA

strand hybridized to ~ 42% and the other hybridized only to 2%. When a correction for pMB9 sequences was made, more than 95% of one mtDNA strand was transcribed. There is extensive (at least 60%) transcription of one strand-equivalent of yeast mtDNA. The extent of transciption and the frequency distribution of total mtRNA populations were also evaluated in yeast grown anaerobically. The results could not be distinguished from those obtained in yeast grown under aerobic conditions. Finally, sequence differences between mitochondrial poly(A+) and poly(A-) RNA were investigated. the hybridization profiles were similar, except for the absence of an initial low level of hybridization at low R_0t values for poly(A+) RNA.

24685 Time-resolved resonance Raman spectroscopy of intermediates of bacteriorhodopsin: the bK_{590} intermediate. Terner, J.; Hsieh, C.L.; Burns, A.R.; El-Sayed, M.A. (Univ. of California, Los Angeles). *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 7, 3046-3050(Jul 1979).

We have combined microbeam and flow techniques with computer subtraction methods to obtain the resonance Raman spectrum of the short lived batho-intermediate (bK_{590}) of bacteriorhodopsin. Comparison of the spectra obtained in ^1H_2O and ^2H_2O, as well as the fact that the bK_{590} intermediate shows large optical red shifts, suggests that the Schiff base linkage of this intermediate is protonated. The fingerprint region of the spectrum of bK_{590}, sensitive to the isomeric configuration of the retinal chromophore, does not resemble the corresponding region of the parent bR_{570} form. The resonance Raman spectrum of bK_{590} as well as the spectra of all of the other main intermediates in the photoreaction cycle of bacteriorhodopsin are discussed and compared with resonance Raman spectra of published model compounds.

24686 Protonmotive cyclic electron flow around photosystem I in intact chloroplasts. Crowther, D.; Mills, J.D.; Hind, G. (Brookhaven National Lab., Upton, NY). *FEBS (Fed. Eur. Biochem. Soc.) Lett.;* **98**: No. 2, 386-390(Feb 1979).

Recent experiments have suggested that cyclic electron flow driven by photosystem I may function to supply a portion of the ATP needed for carbon assimilation in intact chloroplasts. These studies further demonstrated the importance of electron flow from photosystem II in redox poising the photosystem I cycle: the inhibitor DCMU was used to vary the relative activity of the former and show that over-reduction or over-oxidation of the cycle could arise, respectively, from excessive or inadequate photosystem II activity. Another variable shown to influence cycle turnover was the rate of electron flow from the reducing side of photosystem I to electron acceptors and oxygen. In this work, photosystem II was completely inhibited by DCMU, no electron acceptors were provided and dithionite was employed to obtain a sufficiently negative redox poise to support cycling. Dithionite in the concentrations used does not overreduce the cycle possibly due to a slow interaction with electron carriers within the thylakoid membrane. This system permits analysis of the energetic relationships of the photosystem I cycle without interference from linear or pseudocyclic electron transport, and provides the first direct evidence of electrogenic H^+ pumping driven by photosystem I alone in whole chloroplasts.

24687 Changes in ecdysteroids during embryogenesis of the blue crab, callinectes sapidus rathbun. McCarthy, J.F.; Skinner, D.M. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Dev. Biol.;* **69**: 627-633(1979).

Total ecdysteroid titers [estimated by radioimmunoassay (RIA)] in embryos of the blue crab increased from ~ 6 ng 20-hydroxyecdysone equivalents/g in the immature embryo to a maximum of ~ 500 ng 20-hydroxyecdysone equivalents/g in maturing embryos; titers dropped to ~ 300 ng 20-hydroxyecydsone equivalents/g in prehatch embryos. High-pressure reverse-phase chromatography of the embryo extracts resolved five RIA-active components, α-Ecdysone and the polar conjugate of 20-hydroxyecdysone were present in low quantities. The concentration of 20-hydroxyecdysone increased during embryogenesis to a maximum of ~ 160 ng/g in maturing embryos and decreased only slightly in the prehatch embryos. Two unidentified components were also detected and the changes in their concentrations were estimated. One, an apolar component (peak III), accounted for as much as 63% of the total RIA activity as the embryos matured. The estimated concentration of this component increased from 85 ng/g in early embryos to 475 ng/g in maturing embryos, then decreased by 50% in the prehatch embryos. The level of the other, more polar component (peak II) increased from 7.5 to 75 ng/g as the embryos developed. The increase in the concentration of ecdysteroids during embryogenesis indicates that crab embryos have the capacity to synthesize ecdysteroids and suggests that these hormones may have a physiological role in the embryonic development of crustaceans.

24688 Inhibition of DNA excision repair in human cells by Arabinofuranosyl cytosine: effect on normal and xeroderma pigmentosum cells. Dunn, W.C.; Regan, J.D. (Oak Ridge National Lab., TN). *Mol. Pharmacol.;* **15**: 367-374(1979).

The antineoplastic agent arabinofuranosyl cytosine (ara-C) produces an inhibition of the pyrimidine dimer excision system of human DNA repair. Alkaline sucrose gradient analysis of DNA from normal human skin fibroblasts exposed to 20 J/m^2 of ultraviolet radiation (254 nm) shows an accumulation of DNA single-strand breaks when DNA repair is attempted in the presence of 10 μM ara-C. Cells from complementaion groups of xeroderma pigmentosum that are defective in early steps of excision repair show reduced numbers of DNA single strand breaks/10^8 daltons when compared with normal cells. Cesium chloride gradient analysis of radioactive precurser uptake during repair replication indicates that ara-C causes a 6 to 56% reduction in the number of nucleotide bases inserted into the DNA at concentrations of 1 and 10 μM, respectively. These concentrations result in the substitution for deoxycytidine (dCyd) by ara-C of 40 and 100%, respectively, in repaired regions. Repair inhibition is reversed by 50% upon removal of ara-C and by > 95% with the addition of 100 μM dCyd. Chromatography of digested DNA shows that incorporated ara-C is not removed during dCyd reversal, suggesting that ara-C incorporation per se does not play a significant role in the inhibition of repair synthesis. The repair inhibition observed here is dependent on 2 mM hydroxyurea, presumably due to reduction in the intracellular pool of dCyd. The overall results suggest the possibility that ara-C is a weak competitive inhibitor of DNA polymerases associated with ultraviolet-induced excision repair.

24689 Nitrogen fixation in Clear Lake, California. 4. Diel studies on Aphanizomenon and Anabaena blooms. Horne, A.J. (Univ. of California, Berkeley). *Limnol. Oceanogr.;* **24**: No. 2, 329-341(1979).

Day and night measurements of N_2 fixation (as acetylene reduction) were made during spring blooms of Aphanizomenon flos-aquae and two autumn blooms of Anabaena spp. From 9 to 23% of the 24-h fixation occurred between 1100 and 1300 hours. Nitrogen fixation in spring showed complex, physically shallow but optically deep and mobile subsurface peaks of nitrogenase activity, which were totally unrelated to Aphanizomenon biomass but may have been due to diel changes in light penetrating the relatively clear water. Nocturnal fixation was uniformly distributed with depth and accounted for 1/5 to 1/3 of daylight fixation. In more turbid autumn waters, the pattern of N_2 fixation for Anabaena blooms was simpler, with a surface (or near-surface) peak decreasing with depth. Nocturnal fixation was more uniformly distributed with depth. The difference in fixation patterns between the two species is attributable to the interactions of oxygen with the nitrogenase enzyme system. The diel changes in nitrogenase activity suggest a need to establish whether the precursors of nitrogenase accumulate in an oxygen-stable form.

24690 Modulation of erythropoietin concentrations by manipulation of hypercarbia. Miller, M.E.; Howard, D. (Brookhaven National Lab., Upton, NY). *Blood Cells;* **5**: 389-403(1979).

The present studies were done to determine whether preventing the respiratory alkalosis, which is known to occur with acute hypoxic stimuli, would lead to alterations in plasma concentrations of erythropoietin (Ep). Rats were subjected to two acute stresses, hypoxia and blood loss, separately and in combination, with and without the added stress of hypercarbia. Hypercarbia in all experimental groups was associated with a decrease in plasma concentrations of Ep. This reduction in plasma Ep with hypercarbia could not be fully explained by the higher arterial pO_2s or p50s of the hypercarbic rats. Hypercarbia may have indirectly suppressed Ep production by increasing blood flow to the site of Ep production. Alternatively, the cell of origin of Ep could be sensitive to changes in pH and/or pCO_2. It was further demonstrated that neither the onset nor the degree of reticulocytosis could be predicted by the plasma Ep concentrations. It is likely that the removal of red blood cells led to a decrease in marrow transit time with the early emergence of reticulocytes after acute blood loss.

24691 Dependence of mammalian DNA replication on DNA supercoiling. I. Effects of ethidium bromide on DNA synthesis in permeable Chinese hamster ovary cells. Mattern, M.R.; Painter, R.B. (Univ. of California, San Francisco). *Biochim. Biophys. Acta;* **563**: 293-305(1979).

Chinese hamster ovary cells labelled with [^{14}C]thymidine were made permeable, incubated with various concentrations of the intercalating dye ethidium bromide, and centrifuged through neutral sucrose gradients. The gradient profiles of these cells were qualitatively similar to those obtained by centrifuging DNA from untreated, lysed permeable cells through gradients containing ethidium bromide. The sedimentation distance of DNA had a biphasic dependence on the concentration of ethidium bromide, suggesting that the dye altered the amount of NDA supercoiling in situ. The effect of ethidium bromide intercalation on incorporation of [^{3}H]dTMP into acid-precipitable material in an in vitro DNA synthesis mixture was measured. The incorporation of [^{3}H]dTMP was unaffected by less than 1 μg/ml of ethidium bromide, enhanced up to two-fold by 1-10 μg/ml, and inhibited by concentrations greater than 10 μg/ml. Alkaline sucrose gradient analysis revealed a higher percentage of

small DNA fragments (6 to 20 S) in the cells treated with 2 μg/ml ethidium bromide than in control cells. These fragments attained parental size within the same time as the fragments in control cells. In cells treated with 2 μg/ml ethidium bromide, a significant fraction of newly synthesized DNA resulted from new starts, whereas in untreated cells practically none of the newly synthesized DNA resulted from new starts. These results suggest that relaxation of DNA supercoiled structures ahead of the replication fork generates spurious initiations of DNA synthesis and that in intact cells the rate of chain elongation is limited by supercoil regions ahead of the growing point.

24692 Actinomycin D-deoxynucleotide interactions: binding isotherms at the benzenoid and quinoid portions of the drug. Auer, H.E.; Thompson, T.N. (Univ. of Rochester, NY). *Proc. Natl. Acad. Sci. U.S.A.;* **75**: No. 10, 4729-4733(Oct 1978).

Titration of actinomycin D (AMD) with dG and with dG-dC were monitored by circular dichroism at 380 nm and 470 nm. These wavelengths are sensitive predominantly to nucleotide binding processes at the benzenoid and quinoid portions, respectively, of the phenoxazone ring of the drug chromophore . The temperature dependence of these isotherms was analyzed by the van't Hoff equation to obtain values for the enthalpy and entropy changes. For dG these are about -11 kval mol^{-1} and -20 cal mol^{-1} deg^{-1}, respectively, for complex formation at both the benzenoid and quinoid sites (1 cal = 4.184 J). The enthalpy and entropy changes for complex formation with dG-dC remain unchanged at the benzenoid site, but both values are more negative at the quinoid site. These results indicate that the additional process of binding C in the intercalated AMD(dG-dC)$_2$ complex, with respect to the simply stacked AMD-dG$_2$ complex, has distinctive properties at the two sites,reflecting their structural differences. The abilty to resolve binding processes at the two sites by circular dichroism has permitted us to suggest assignments for the two ^{31}P magnetic resonance lines from the phosphodiester groups observed in the AMD-(pdG-dC)$_2$ complex.

24693 Picosecond fluorescence studies of exciton migration and annihilation in photosynthetic systems. A review. Campillo, A.J.; Shapiro, S.L. (Los Alamos Scientific Lab., NM). *Photochem. Photobiol.;* **28**: 975-989(1978).

In this paper picosecond fluorescence studies of exciton dynamics in photosynthesis are reviewed. Some of the exciton interactions that led to artifacts in early picosecond data and outline procedures for avoiding their presence are discussed. In the case of high intensity single pulse exciation ($> 10^{13}$ photons cm^2), the dominant mechanism is singlet-singlet fusion, manifesting itself by a decrease in the observed lifetime and quantum efficiency of fluorescence. The manner in which excitons interact in vivo provides as indicator of the topology of the photosynthetic unit (PSU). The shape of the fluorescence quenching curve, as a function of intensity, in particular, can be used to test various models. In addition to fluorescence quenching curves, the results of fluorescence decay following ps laser flshes, using an ultrafast streak camera are also reported in four types of systems: (1) organic crystal analogues; (2) chromatophores of various mutants of the photosynthetic bacteria. Rhodopseudomonas sphaeroides; (3) intact cells of the green alga, Chlorella and (4) chloroplasts of higher plants (e.g., spinach).

24694 Regulation of vitamin D metabolism in the kidney. DeLuca, H.F. (Univ. of Wisconsin, Madison). pp 195-209 of Phosphate metabolism. Massry, S.G.; Ritz, E. (eds.). New York, NY; Plenum Press (1977).

The regulation of vitamin D metabolism in the kidney as mediated by renal 25-OH-D_3 hydroylases is evaluated in terms of molecular mechanisms and molecular responses. The biochemical roles of calcium, phosphates, and parathormone are discussed as response modifying factors. (DS)

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 24717, 24736, 24741

24695 (UR—3490-1559) **Biochemical studies of mouse brain tubulin: colchicine binding (DEAE-cellulose filter) assay and subunits (α and β) biosynthesis and degradation (in newborn brain).** Tse, C.F. (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1978. Contract AC02-76EV03490. 220p. Dep. NTIS, PC A10/MF A01.

Thesis.

A DEAE-cellulose filter assay, measuring [^{3}H]colchicine bound to colchicine binding protein (CBP) absorbed on filter discs, has been modified to include lM sucrose in the incubation medium for complexing colchicine to CBP in samples before applying the samples to filter discs (single point assay). Due to the much greater stability of colchicine binding capacity in the presence of lM sucrose, multiple time-point assays and least squares linear regression analysis were not necessary for accurate determination of CBP in hybrid mouse brain at different stages of development. The highest concentrations of CBP were observed in the 160,000g supernatant and pellet of newborn brain homogenate. Further studies of the modified filter assay documented that the assay has an overall counting efficiency of 27.3%, that DEAE-cellulose filters bind and retain all tubulin in the assay samples, and that one molecule of colchicine binds approximately one molecule of tubulin dimer. Therefore, millimoles of colchicine bound per milligram total protein can be used to calculate tubulin content. With this technique tubulin content of brain supernatant was found to be 11.9% for newborn, and 7.15% for 11 month old mice. Quantitative densitometry was also used to measure mouse brain supernatant actin content for these two stages. In vivo synthesis and degradation rates of tubulin α and β subunits of two day mouse brain 100,000g supernatant were studied after intracerebral injection of [^{3}H]leucine. Quantitative changes of the ratio of tritium specific activities of tubulin α and β subunits with time were determined. The pattern of change was biphasic. During the first phase the ratio decreased; during the second phase the ratio increased continuously. An interpretation consistent with all the data in this study is that the α sub unit is synthesized at a more rapid rate than the β subunit. (ERB)

24696 Fidelity of fractionated deoxyribonucleic acid polymerases from human placenta. Krauss, S.W.; Linn, S. (Univ. of California, Berkeley). Contract EY-765-03-0034. *Biochemistry;* **19**: No. 1, 220-228(8 Jan 1980).

Deoxyribonucleic acid (DNA) polymerase activities from human placenta have been fractionated and classified amoung the α, β, and γ types by using the criteria of size, ability to utilize various synthetic template-primers, and sensitivity to phosphate, N-ethylmaleimide, aphidicolin, and 2', 3'-dideoxythymidine 5'-triphosphate. Reverse transcriptase and δ-polymerase activities were not detected. α activity resolved into two fractions on diethylaminothylcellulose which could be distinguished catalytically by their template-primer preferences. Similarly, multiple species of β-polymerase were obtained upon purification by phosphocellulose or glycerol gradient sedimentation. Each DNA polymerase fraction was tested for misincorporation frequencies with synthetic template-primers and either Mn^{2+} or Mg^{2+}. All α-polymerases copied the templates with relatively high fidelity, though absolute values dependended upon the length of primer and the primer/template ratio. With Mn^{2+} present, an 8.6S species of β-polymerase copied the synthetic templates very accurately, but 6.3S and 4.6S forms copied the same polymers relatively unfaithfully. The 8.6S form could be converted to a 4.8S species with a concomitant loss of fidelity. γ-Polymerase also copied deoxyribopolymers relatively inaccurately in the presence of Mn^{2+}. The relative concentrations of complementary to noncomplementary triphosphates affected the frequency of misincorporation for β and γ activities. Conversely, α-polymerase did not show similar behavior at saturating triphosphate concentrations. None of the placental polymerase fractions contained exonuclease activity that could discriminate between complementary and noncomplementary 3' ends.

24697 Rapid ATP assays in perfused mouse liver by ^{31}P NMR. McLaughlin, A.C. (Brookhaven National Lab., Upton, NY); Takeda, H.; Chance, B. *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 11, 5445-5449(Nov 1979).

^{31}P NMR was used to continuously monitor ATP and inorganic phosphate levels in perfused mouse liver. Under optimal conditions, the time resolution of the technique was approximately 1 min. In the absence of any metabolic perturbations the ATP level remained constant for at least 2 hr and decreased by only approximately 20% in 18 hr. Both ATP and inorganic phosphate levels responded to alterations in the oxygen supply to the liver. The half-time for this response was approximately 1 min and the response to short periods of hypoxia or ischemia was partially reversible. The addition of insulin caused only a minor decrease in the ATP level but significantly decreased the rate of response of ATP and phosphate levels to hypoxia and ischemia.

24698 Comparison of the effects of prostaglandin E_2 and parathyroid hormone on plasma calcium concentration and osteoclast function. Vanderwiel, C.J.; Talmage, R.V. (Univ. of North Carolina, Chapel Hill). *Endocrinology;* **105**: No. 3, 588-594(Sep 1979).

Prostaglandin Es (PGEs) are known to be stimulators of bone resorption, but there are conflicting reports as to the effects of PGE and synthetic 16,16-dimethyl-PGE_2 on plasma calcium concentration. This study involves iv infusion of PGE_2 or its dimethyl analog into male thyroparathyroidectomized, parathyroidectomized, or thyroidectomized rats. Rats were given an initial dose of 5 μg PGE, or its analog, followed immediately by infusion at a rate of 10 μg/ml-h for up to 12 h. An additional group of rats was injected with 0.01 U parathyroid hormone. (PTH)/g BW-h. ^{45}Ca was injected ip at either 10 h or 6 days before commencing the experiment. In contrast to PTH, PGE_2 and its analog affected bone lining cells only by increasing their quantity of filipodia. The PGs and PTH influenced osteoclast function by increasing the size of the population and the activity of individual osteoclasts. However, only PTH raised the plasma calcium level. PTH produced the expected results in plasma ^{45}Ca and ^{45}Ca specific activity values. PGE_2 infusion did not

affect ^{45}Ca values when ^{45}Ca was injected 10 h before start of infusion, but it did increase ^{45}Ca values when the isotope was injected 6 days earlier in spite of having no effect on plasma calcium concentrations. The data permit the conclusion that PGs appear to duplicate the action of PTH on osteoclasts but not on plasma calcium control. This is in support of the concept of a separation of changes in the rate of bone resorption from the control of plasma calcium concentration.

24699 Sequence complexity of polyadenylated ribonucleic acid from soybean suspension culture cells. Silflow, C.D.; Hammett, J.R.; Key, J.L. (Univ. of Georgia, Athens). Contract DOE(38-1)643. *Biochemistry;* **18**: No. 13, 2725-2731(26 Jul 1979).

The sequence complexity of total poly(A)RNA from a hibher plant system, soybean cultured cells, was determined. Labeled cDNA synthesized from the poly(A) RNA hybridized exclusively with the unique sequence component of total soybean DNA. Analysis of the hybridization reaction between cDNA and the poly(A) RNA template revealed three abundance classes in the poly(A) RNA. These classes represent 18, 44, and 38% of the poly(A) RNA and contain information for approximately 60, 1900, and 30,000 different 1400-nucleotide RNA molecules. From these results, the total sequence complexity of poly(A) RNA was estimated to be 4.5 x 10^7 nucleotides. Saturation hybridization of labeled unique DNA with RNA showed that the total cell RNA represents 12.4% of the unique DNA sequence complexity, or 6.4 x 10^7 nucleotides, while poly(A) RNA represents 8.7% of the unique DNA sequence complexity, or 3.3 x 10^7 nucleotides. Thus, it is estimated that 50 to 70% of total RNA sequence complexity is contained in poly(A) RNA in these cells.

24700 Dependence of mammalian DNA replication on DNA supercoiling. II. Effects of novobiocin on DNA synthesis in Chinese Hamster ovary cells. Mattern, M.R.; Painter, R.B. (Univ. of California, San Francisco). *Biochim. Biophys. Acta;* **563**: 306-312(1979).

Novobiocin, an inhibitor of gyrase-induced DNA supercoiling and DNA replication in prokaryotes, inhibited the incorporation of DNA precursors into DNA in both intact and permeable Chinese hamster ovary cells; much higher concentrations were required for permeable cells, in which no new replicons were initiated. Nucleoids were prepared from cells that were incubated for 60 min with 200 μg/ml novobiocin, made permeable, and incubated with 0 to 50 μg/ml ethidium bromide. Sedimentation of the nucleoids in neutral sucrose gradients suggested that the number of supercoils in the average nucleoid had been reduced by prior incubation with novobiocin. In intact cells, novobiocin is required inside the cell for continued inhibition of DNA synthesis, suggesting that it does not act directly on the DNA. Alkaline sucrose gradient profiles of DNA synthesized in the presence of novobiocin in intact cells indicated that the drug inhibited replicon initiation while having little if any effect on chain elongation. These data are consistent with the idea that an activity similar to the bacterial gyrase generates supercoils in mammalian DNA and produces the proper conformation for the initiation of DNA replication.

CYTOLOGY

REFER ALSO TO CITATION(S) 24688, 24691, 24729, 24730, 24739, 24743, 24779

24701 Improved method and apparatus for electrostatically sorting biological cells. Merrill, J.T. US Patent Application 039,527. [nd]. 16p.

An improved method of sorting biological cells in a conventional cell sorter apparatus includes generating a fluid jet containing cells to be sorted, measuring the distance between the centers of adjacent droplets in a zone thereof defined at the point where the fluid jet separates into descrete droplets, setting the distance between the center of a droplet in said separation zone and the position along said fluid jet at which the cell is optically sensed for specific characteristics to be an integral multiple of said center-to-center distance, and disabling a charger from electrically charging a specific droplet if a cell is detected by the optical sensor in a position wherein it will be in the neck area between droplets during droplet formation rather than within a predetermined distance from the droplet center.

24702 (CONF-7810136—2) Limits to life at low temperatures and at reduced water contents and water activities. Mazur, P. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 47p. Dep. NTIS, PC A03/MF A01.

From 4. College Park colloquium on chemical evolution, limits of life; College Park, MD, USA (18 Oct 1978).

Liquid water is generally considered an absolute requisite for functional terrestrial life; consequently, life is expected to function only over the range of temperatures that permit its existence. These limits, however, do not apply to cell survival. Some can survive the closest attainable approach to 0°K and some can survive the loss of over 99% of their water. The author discusses various aspects of the phenomena of cell survival at low temperatures. Included are sections on events occurring during freezing and thawing of cells, the consequences of cell dehydration, limits to cell survival, and minimum temperatures for cell growth. (ACR)

24703 Inhibition of cytotoxic T lymphocytes with concanavalin A. Tartof, D. (Univ. of Chicago, IL). *Cell. Immunol.;* **50**: No. 1, 48-57(1 Mar 1980).

Increasing concentrations of concanavalin A (ConA) were found to increasingly inhibit immunologically specific cytotoxic Tlymphocyte (CTL)-mediated cytolysis. Even concentrations of ConA that best enabled nonspecific cytolysis were found to inhibit immunologically specific cytolysis by the same population of effector cells. Higher concentrations of ConA inhibited both specific and nonspecific cytolysis. Similar increasing concentrations of succinyl ConA enabled nonspecific lysis by CTL but did not appreciably inhibit specific lysis by the same cells. Increasing concentrations of ConA inhibited cytolysis and capping of the Thy 1.2 surface antigen to comparable degrees in the same effector cell population. These results indicate that ConA may inhibit CTL-mediated cytolysis by interfering with the mobility of certain moieties on the effector cell surface.

24704 Purification of two spectrin-binding proteins: biochemical and electron microscopic evidence for site-specific reassociation between spectrin and bands 2.1 and 4.1. Tyler, J.M.; Hargreaves, W.R.; Branton, D. (Harvard Univ., Cambridge, MA). *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 10, 5192-5196(Oct 1979).

Two peripheral proteins of the human erythrocyte membrane that are capable of forming a stable complex with spectrin have been purified. The proteins, band 2.1 (M/sub r/ 210,000) and band 4.1 (M/sub r/ 82,000), are water soluble and exist as monomers in solution. Both exhibit strong, specific binding to purified spectrin molecules as determined by cosedimentation in sucrose gradients and both enhance binding to spectrin-depleted, inside-out vesicles that have been stripped of bands 2.1 and 4.1. Rotary replicas of bound material reveal site-specific associations among native, but not heat-denatured, molecules.

24705 In vitro properties of epithelial cell lines established from human carcinomas and nonmalignant tissue. Smith, H.S. (Peralta Cancer Research Inst., Oakland, CA). *J. Natl. Cancer Inst.;* **62**: No. 2, 225-230(Feb 1979).

A series of 16 epithelial cell lines derived from human carcinomatous and nonmalignant epithelial tissues were characterized for markers known to correlate with neoplasia in various model systems. The goal of these studies was to determine which in vitro transformation properties were relevant to human epithelial malignancy. The parameters tested were (1) colony formation in Methocel and on confluent monolayers of normal human epithelial cells and fibroblasts and (2) tumor induction in immunosuppressed mice. Cell lines derived from normal tissue and nonmalignant tissue peripheral to cancerous lesions were generally negative for these properties, whereas the carcinomaderived lines varied in their expression (some lines being more abnormal than others). In most cases, the lines derived from metastatic lesions had more abnormal properties than did those derived from primary carcinomas.

24706 Light-dark regulation of starch metabolism in chloroplasts. II. Effect of chloroplastic metabolite levels on the formation of ADP-glucose by chloroplast extracts. Kaiser, W.M.; Bassham, J.A. (Univ. of California, Berkeley). *Plant Physiol.;* **63**: 109-113(1979).

The rate of ADP-glucose formation from [^{14}C]glucose 6-phosphate and ATP by the soluble fraction of lysed chloroplasts is studied as a function of the levels of metabolites (3-phosphoglycerate, orthophosphate, hexose monophosphate, and ATP) as determined in whole chloroplasts of Spinacia oleracea in light and dark. A change in 3-phosphoglycerate concentration (from 4 to 1.4 millimolar, as in whole chloroplasts during light-dark transition) decreases the rate of ADP-glucose formation 6- to 7-fold. An increase in hexose monophosphate concentration from 2 to 6 millimolar, which occurs at the same time in whole chloroplasts, stimulates ADP-glucose formation only slightly. At constant levels of orthophosphate (4 millimolar) and 3-phosphoglycerate (4 millimolar), a change in ATP concentration from 0.2 to 1 millimolar causes an immediate 4- to 5-fold increase in the rate of ADP-glucose formation. Another significant stimulation of ADP-glucose formation (about 4- to 6-fold) is obtained after addition of dithiothreitol at high concentrations (50 millimolar). A simultaneous increase in the concentrations of 3-phosphoglycerate, ATP, and dithiothreitol, with orthophosphate and Mg^{2+} being constant at 4 and 5 millimolar, respectively, causes a 130-fold increase in the rate of ADP-glucose formation (from 0.042 to 5.49 microgram atoms carbon per milligram chlorophyll per hour). The role of these and other factors is discussed with respect to light-dark regulation of starch formation in intact chloroplasts.

24707 Incorporation of transport molecules into black lipid membranes. Blumenthal, R. (National Cancer Inst., Bethesda, MD); Shamoo, A.E. pp 215-245 of Receptors. Vol. 1. O'Brien, R.D. (ed.). New York, NY; Plenum Publishing Corporation (1979).

Methods of formation and composition of black lipid membranes for assay use of the bimolecular lipid membrane (BLM) technique are discussed. The utilization of the BLM technique for transport molecules permeability and receptor site studies are discussed. (DS)

24708 Primary avian tendon cells in culture: an improved system for understanding malignant transformation. Schwarz, R.I.; Farson, D.A.; Soo, W.J.; Bissell, M.J. (Univ. of California, Berkeley). *J. Cell Biol.;* **79**: 672-679(Dec 1978).

Primary avian tendon (PAT) cells which maintain their differentiated state in culture are rapidly transformed by Rous sarcoma virus. By criteria of morphology, increased rate of 2-deoxyglucose uptake, and loss of density dependent growth control, PAT cells transform as well as their less differentiated counterpart, chick embryo fibroblasts. In addition, the percentage of collagen produced by PAT cells drops on transformation by an order of magnitude, from 23 to 2.5%, but is unaffected by viral replication of a transformation-defective mutant. The responsiveness of normal and transformed PAT cells to various environmental factors changes dramatically upon transformation. Normal PAT cells respond to the presence of ascorbate and high cell density by raising the level of collagen synthesis from 5 to 23%. Transformed PAT cells are totally unresponsive. These and previously reported results lead us to postulate that the breakdown in the normal regulatory mechanisms used by the cell to maintain the differentiated state is related to or is responsible for the onset of malignant transformation.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 24700

GENETICS

REFER ALSO TO CITATION(S) 24667, 24728, 24737, 24750, 24763, 24764, 24766, 24774

24709 (COO—4159-5) **Genetic and developmental study of a complex locus in the house mouse. Progress report, August 1, 1978-June 1, 1979.** Bennett, D. (Sloan-Kettering Inst. for Cancer Research, New York (USA)). Jun 1979. Contract AC02-77EV04159. 5p. Dep. NTIS, PC A02/MF A01.

More than 50 T/t-complex and other mouse chromosome variants are being maintained for genetic study and for distribution to other investigators. Mapping experiments within a viable t-haplotype have been completed, and show conclusively that this variant virtually completely suppresses recombination for three centimorgans distal to itself, but enhances recombination in a 4 centimorgan region distal to that. Complementation tests of a new lethal t-haplotype, t/sup w/^{75}, which have shown that it contains two lethal factors characteristic of both the t/sup wl/ and the t/sup w^5/ complementation groups have been completed. Deletion mapping has been used to study transmission ratio distortion, and these experiments show clearly that a gene or genes on the chromosome homologous to the t-bearing one have a pronounced effect in governing the degree of distortion. Other experiments to extract and analyze t-haplotypes from wild populations are continuing, as in the analysis of viable recombinant t-variants produced by existing lethal t-haplotypes.

24710 Validation of conditions for efficient detection of HPRT and APRT mutations in suspension-cultured Chinese hamster ovary cells. Thompson, L.H.; Fong, S.; Brookman, K. (Univ. of California, Livermore). *Mutat. Res.;* **74**: 21-36(1980).

Conditions for reliable and efficient assay of mutations affecting the activity of HPRT (hypoxanthine phosphoribosyltransferase EC 2.4.2.8) and APRT (adenine phosphoribosyltransferase EC 2.4.2.7) have been determined for a strain of CHO (Chinese hamster ovary) cells that has been adapted for rapid growth both in suspension culture and in monolayer. To facilitate measurement of mutation at the aprt locus, clones were derived that are presumptively heterozygous at that locus. At a limiting concentration of 8 μg/ml of azaadenine, 14/16 of the resistant clones picked and tested had ~ 1/2 of the APRT activity of the wild-type cells. One such clone, strain AA8, was chosen for further studies and found to be readily mutable to resistance to 80 μg/ml azaadenine. Most of the highly resistant colonies isolated (21/24) had very low in vitro APRT activity. The optimal conditions for detection of TG/sup r/ and AA/sup r/ mutations were determined for two critical parameters, expression time and cell density. Cultures treated with mutagen either in monolayer or in suspension were allowed to express mutations in suspension. The expression of mutations induced by uv light, EMS, and ICR-191 was complete by 3 days for AA/sup r/ and by 4 to 5 days for TG/sup r/. The time required to reach a maximal frequency of mutants was essentially independent of the type of mutagen and the level of survival after treatment. Induced mutation frequencies for both loci were notably stable during the time intervals examined. With respect to cell-density conditions, both markers were detected at frequencies that were independent of the cell inocula over the range of 1 x 10^5 to 1 x 10^6 cells per 100-mm petri dish (i.e. 1.6 x 10^3 to 1.6 x 10^4 cells/cm^2) containing 20 ml of medium. These results were obtained with both mutagenized populations and with reconstructed mixtures obtained by adding drug-resistant cells to varying numbers of wild-type cells.

24711 Assignment of human β-, γ-, and δ-globin genes to the short arm of chromosome 11 by chromosome sorting and DNA restriction enzyme analysis. Lebo, R.V. (Howard Hughes Medical Institute Lab., San Francisco, CA); Carrano, A.V.; Burkhart-Schultz, K.; Dozy, A.M.; Yu, L.C.; Kan, Y.W. *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 11, 5804-5808(Nov 1979).

Normal human metaphase chromosomes isolated from fibroblasts were resolved into 14 peaks based on total Hoechst 33258 fluorescence and sorted with the fluorescence-activated cell sorter. The chromosomal DNA was extracted and characterized by EcoRI analysis. As expected, analysis of the peak containing chromosomes 16 and 18 detected the α-globin genes and of the peak containing chromosomes 9, 10, 11, and 12 detected the β-, γ-, and δ-globin genes. Translocations were then used to localize further the β-, γ-, and δ-globin genes. The first translocation t(11;22)(q25;q11), which moved nearly all of chromosome 11 to a different peak, confirmed that the β-, γ-, and δ-globin genes are on this chromosome. The second, t(4;11)(q25;q13), which moved the distal portion of the long arm of chromosome 11 to a new peak, showed that the genes are not in this segment. The third, t(X;11)(q11;p13), moved the distal region of the short arm of chromosome 11 to a peak which now contained the β-, γ-, and δ-globin genes. Therefore, the β-, γ-, and δ-globin genes reside on the distal portion of the chromosome 11 short arm including bands p13, p14, and p15. This sorting method may be used generally to assign other genes to chromosomal segments of the entire chromosome complement.

24712 Mutator affecting the region of the iso-1-cytochrome c gene in yeast. Liebman, S.W. (Univ. of Rochester, NY); Singh, A.; Sherman, F. *Genetics;* **92**: No. 3, 783-802(Jul 1979).

The mutator gene DEL1 in the yeast Saccharomyces cerevisiae causes a high rate of formation of multisite mutations that encompass the following three adjacent genes: CYC1, which determines the structure of iso-1-cytochrome c; RAD7, which controls uv sensitivity; and OSM1, which controls osomotic sensitivity. The simplest hypothesis is that these multisite mutations are deletions, although it has not been excluded that they may involve other types of gross chromosomal aberrations. In contrast, normal strains do not produce such multisite mutations even after mutagenic treatments. The multisite mutations arise at a rate of approximately 10^{-5} to 10^{-6} per cell per division in DEL1 strains, which is much higher than rates observed for mutation of genes in normal strains. For example, normal strains produce all types of cyc1 mutants at a low rate of approximately 10^{-8} to 10^{-9}. No evidence for multisite mutations was obtained upon analysis of numerous spontaneous ade1, ade2, met2 and met15 mutants isolated in a DEL1 strain. DEL1 segregates as a single Mendelian gene closely linked to the CYC1 locus. DEL1 appears to be both cis- and trans-dominant. The location of the DEL1 gene and the lack of effect on other genes suggest that the mutator acts only on a region adjacent to itself.

24713 Frequency-dependent selection at the PGM-1 locus of Drosophila pseudoobscura. Snyder, T.P.; Ayala, F.J. (Univ. of California, Davis). *Genetics;* **92**: No. 3, 995-1003(Jul 1979).

Frequency-dependent fitness was studied at the Pgm-1 locus of Drosophila pseudoobscura with respect to two fitness components: rate of development and larva-to-adult survival. The Pgm-1 locus is very polymorphic with only two alleles, Pgm-1^{100} and Pgm-1^{104}, occurring at high frequencies. For each of these two alleles, 20 homozygous strains were obtained from a sample of 1140 wild-inseminated females. First-instar larvae of the two genotypes were combined in a set of eight different frequencies: 0.0, 0.10, 0.25, 0.40, 0.60, 0.75, 0.90, and 1.0. Frequency-dependent fitness effects were observed for the two survival-related fitness components examined: larvae of the less common genotype develop faster and have a higher probability of survival than larvae of the more common genotype. The rate of survival at intermediate genotypic frequencies is similar to that in pure cultures. If selection acted solely as frequency-dependent effects on survival-related components of fitness, the equilibrium frequency of the Pgm-1^{100} allele would be 0.615 for a two-genotype system, which fits an observed frequency range for this allele in nature between 0.55 and 0.71. Experimentally created linkage disequilibrium was excluded from the experiment by using a large number of independent strains. It is nevertheless possible that the frequency-dependent selection may not affect the Pgm-1 locus per se, but may reflect a linkage disequilibrium present

in the natural population. Even if this were the case, the frequency-dependent selection could affect the frequency of the Pgm-1 alleles in nature.

24714 Is the product of the src gene a promoter. Bissell, M.J.; Hatie, C.; Calvin, M. (Univ. of California, Berkeley). *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 1, 348-352(Jan 1979).

Addition of a potent promotor, 12-O-tetradecanoylphorbol 13-acetate (TPA), to primary avian tendon or chicken embryo fibroblast cells infected with a temperature-sensitive mutant of Rous sarcoma virus produced a complete transformed phenocopy at the nonpermissive temperature by the criteria tested. While normal, uninfected cultures also shifted towards a transformed phenotype after TPA addition, they did not achieve the same degree of morphological and biochemical alteration seen in virus-infected, TPA-treated cells. It is proposed that viral carcinogenesis, despite its rapidity, may occur in two stages: an initiation step caused by expression of a part of viral genome other than src (or by integration) and a promotion step (itself a multistep process) caused by the activation of the src gene. The src gene product could be enhanced or replaced by other promoting agents.

24715 Genetics of mutagen induced non-lethal chlorophyll mutants in pearl millet. Hanna, W.W.; Burton, G.W.; Powell, J.B. (Georgia Univ., Tifton). Contract EY-76-S-09-0637. *J. Hered.;* **69**: 273-274(1978).

Chlorophyll mutations are useful markers for studying gene action, mapping chromosomes, determining the effects of mutagenic agents on plants, and conducting other fundamental studies of crop plants. The pearl millet, Pennisetum americanum (L.) Leeke., radiation breeding program at Tifton, Georgia, has yielded hundreds of mutants. Genetic and descriptive information on pearl millet mutants has been reported for lethal chlorophyll-deficient seedlings, trichomeless, female sterility, and stubby head, a facultative apomict. However, inheritance and linkage information on these pearl millet mutations is limited. The objectives of this study were to describe and report on the inheritance of two new, induced, nonlethal chlorophyll mutants and to determine their linkage relationships with other mutations.

METABOLISM

REFER ALSO TO CITATION(S) 24706, 24715, 24718, 24719

24716 Pituitary-adrenal response in neonatal rats. Guillet, R.; Saffran, M.; Michaelson, S.M. (Univ. of Rochester School of Medicine and Dentistry, NY). *Endocrinology;* **106**: No. 3, 991-994(Mar 1980).

Neonatal rats were, until recently, believed to be relatively nonresponsive to stress. With improved methods now available, rat pups as young as 1-2 days of age have been found to have basal and stimulated plasma corticosterone (B) values approaching those of adults but have very low values at 4-11 days which increase thereafter and reach adult values at about 21 days of age. We examined the responsiveness of neonatal rats to the administration of a crude preparation of corticotropinreleasing factor (CRF) and ACTH to determine the locus of the variation with age of the response. Plasma B increased in 1-day-old rats after ACTH or CRF. In 7-day-old rats, neither caused increases in plasma B. Some response after these stimuli was elicited in 14-day-old rats, and the responses of 21-day-old rats approached those in adults. Adrenal tissue from rats of the same ages showed a pattern of sensitivity to ACTH in vitro similar to that in vivo, except that the response of adrenals from 21-day-old rats was still feeble. Pretreatment of rat pups for the first 6 postnatal days with ACTH or corticosterone resulted in a moderate increase in plasma B after CFR or ACTH on day 7. The postnatal fall in sensitivity is partially explained by a decreased adrenal sensitivity to ACTH.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 24697

24717 Effects of ethanol on alanine metabolism in perfused mouse liver studied by ^{13}C NMR. Cohen, S.M. (Bell Laboratories, Murray Hill, NJ); Shulman, R.G.; McLaughlin, A.C. *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 10, 4808-4812(Oct 1979).

Time courses of ^{13}C labeling from alanine and ethanol in perfused mouse livers have been followed by NMR. The enrichment at specific carbons of glucose, glutamate, glutamine, aspartate, acetate, acetoacetate, β-hydroxybutyrate, and lactate has been measured. The specific labeling of glutamate in the presence of labeled alanine and labeled or unlabeled ethanol shows that, under these conditions, alanine enters the tricarboxylic acid cycle almost exclusively through pyruvate carboxylation, whereas ethanol is the exclusive source of acetyl-CoA. In the absence of ethanol, the alanine label flows through both paths. By comparing the scrambling of ^{13}C between C3 and C2 of glutamate it is possible to estimate the mitochondrial fumarase activity; the C6-to-C5 ratios in glucose give the additional scrambling by cytosolic fumarase activity. In addition, the C6-to-C1 and C5-to-C2 ratios in glucose show that there is about 15% flux through the pentose cycle. Finally, the C4-to-C2 ratios in glutamine and glutamate are unequal at any time (the glutamine labels reflect the label distribution in glutamate measured 1 hr earlier), providing a method for studying flow through glutamine synthetase in situ.

MEDICINE

REFER ALSO TO CITATION(S) 24692, 24705, 24727

24718 Changes in plasma lipoprotein distribution and formation of two unusual particles after heparin-induced lipolysis in hypertriglyceridemic subjects. Forte, T.M.; Kraus, R.M.; Lindgren, F.T.; Nichols, A.V. (Univ. of California, Berkeley). *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 11, 5934-5938(Nov 1979).

Lipoprotein morphology and distribution were studied in three moderately to severely hypertriglyceridemic patients after heparin-induced lipolysis. Lipoprotens with a flotation rate of S/sub f/^{0} 12 to 20 in rho 1.063-g/ml NaCl solution increased substantially in mass 2.5 to 10 min after heparin administration. This fraction contained 40- to 120-nm flattened particles and increased concentrations of phospholipid and free cholesterol. At 2.5 and 10 min after heparin, the high density lipoproteins (HDL) of rho, 1.126 to 1.21 g/ml contained small (5.8-nm diameter) spherical particles. Both types of particles disappeared 30 to 60 min after heparin. Results indicated that with lipolysis HDL_3 may be transformed into HDL/sub 2a/ by incorporation of chylomicron and very low density lipoprotein constituents. It is suggested that the 40 to 120-nm particles represent surface fragments of chylomicrons and very low density lipoproteins generated during lipolysis, whereas the 5.8-nm particles are produced either by fragmentation of the large surface constituents or by loss of lipid from existing HDL_3.

24719 Analysis of iron content in individual human red blood cells by electron microprobe and scanning electron microscope. Davis, D. (Univ. of California, Berkeley). *Micron;* **9**: 175-190(1978).

The iron content of single human red blood cells has been assessed using electron microprobe analysis and scanning electron microscope. Cells for microanalysis consist of a fixed-washed and freeze-dried preparation. This preparative procedure improves stability and spatial resolution of the analytic method. The reference standard employs compressed pellets of purified iron-containing human hemoglobin and human albumin, respectively. The cell preparation and reference standard remain stable for long periods of time. Differences in Fe content and its distribution among individual red cells from both normal subjects and sickle cell anaemia patients have been measured by the quantitative and semiquantitative techniques (wavelength and energy dispersive x-ray spectrometry). There are several points which can be made from this study. One concerns the estimate of iron on a cell by cell basis, the average variation among cells being slightly over 13%, ranging from 6% to 19.4% by individuals (samples) or from 11 to 14% by ethnic groups. These differences are thus closely comparable across ethnic grouping with a possibility of high level in Asians and lower level in sickle cell anaemia patients.

UNSEALED RADIONUCLIDES IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 24562

24720 Critical examination of some newly available standards for liquid scintillation counting. Gordon, B.E. (Univ. of California, Berkeley). *Anal. Biochem.;* **102**: No. 1, 163-166(Feb 1980).

Some newly available encapsulated sources of carbon-14 and tritium have been evaluated for their usefulness as accurate, convenient internal standards in liquid scintillation counting. They have been found to be as accurate and reproducible as claimed and provide the practitioner with a clean, rapid method for using the widely applicable internal standard method. The water-soluble tritium standard (sucrose) requires a minimum water concentration (1.3% for Aquasol-2) in a detergent cocktail before it will completely dissolve. Efficiency determination of colored and gelled samples is considerably simplified as in the preparation of quenched standard sets in any cocktail system.

EXTERNAL RADIATION IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 25105

24721 Increased tissue differentiation using color display of multiple-energy CT scans. Akutagawa,W.M.; Huth, G.C.; Levis, R.E.; Drianis, G.C.; Davis, R.L. (Univ. of Southern California School of Medicine, Los Angeles). Contract EY-76-S-03-0113. *Radiology;* **134**: No. 3, 739-756(Mar 1980).

From 66. scientific assembly and annual meeting of the Radiological Society of North America; Dallas, TX, USA (16 Nov 1980).

Just as the average value of the attentuation coefficient can be represented by the brightness of the pixel, the energy structure of the attenuation coefficient determines its hue. This can be measured by filtering the x-ray beam with W, Pb, and Sn at 100, 120, and 140 kVp, respectively. The color differences seen in (a) CT images of phantom materials such as iodine and calcium, (b) brain specimens containing hemmorrhage, meningioma, glioblastoma, or metastases, and (c) preliminary in vivo head and body scans represent variations in chemical composition across the tissue section. Measurements show that energy-selective filtration increases the separation between effective energies while reducing the dose for the same number of transmitted x rays.

EXTERNAL RADIATION IN THERAPY

REFER ALSO TO CITATION(S) 24748

24722 Calculation of ionization frequency distributions in small sites. Wilson, W.E. (Pacific Northwest Lab., Richland, WA); Paretzke, H.G. Contract EY-76-C-06-1830. *Radiat. Res.;* **81**: No. 3, 326-335(Mar 1980).

Ionization frequency distributions for 1- to 4-MeV protons have been calculated using Monte Carlo techniques for an absorber site having an effective diameter of 250 nm (unit density materials) and results compared with experiment. For proton tracks passing through the absorber site, the calculated frequency distributions, mean ionization, and relative variance agree very well with experiment. The results suggest that the Monte Carlo method, employing sophisticated source terms, can be used effectively to calculate ionization and energy deposition in sites too small for experimental techniques.

24723 Energy deposition in nanometer regions by 377 MeV/nucleon ^{20}Ne ions. Varma, M.N.; Baum, J.W. (Brookhaven National Lab., Upton, NY). Contract EY-76-C-02-0016. *Radiat. Res.;* **81**: No. 3, 355-363(Mar 1980).

Dose as a function of radial distance from a ^{20}Ne ion beam was determined. These ions had 377 MeV/nucleon energy and were obtained at the Bevalac facility of Lawrence Berkeley Laboratory. A variable pressure ionization chamber and a double-mesh wall ionization chamber (approximating a wall-less ionization chamber) were used. Linear energy transfer restricted in distance (LET/sub r/) was also determined and the data were extrapolated to obtain LET/sub ∞/. Simulated distances studied were from about 58 A to 1010 μm of tissue assumed to have a density of 1 g/cm^3. Experimental results were compared with theoretical calculations; the experimental values on the average were lower by about 6% over the range of distances studied.

24724 Electron mean free paths in solid organic insulators. Ashley, J.C.; Williams, M.W. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Radiat. Res.;* **81**: No. 3, 364-373(Mar 1980).

A simple expression is presented which can be used to estimate the mean free paths of electrons in solid organic insulators as a function of the electon energy. Input parameters are the molecular weight and the density of the organic sample. The range of validity is 100 eV to 10 keV. It is demonstrated that, for this class of materials, the electron mean free path is, to a good approximation, inversely proportional to the valence electron density for a given electron energy.

24725 High LET dose measurements in patients undergoing pion radiotherapy. Richman, C.; Kligerman, M.M.; von Essen, C.; Smith, A.R. (Univ. of New Mexico Cancer Research and Treatment Center, Los Alamos). *Radiat. Res.;* **81**: No. 3, 455-472(Mar 1980).

Thin silicon detectors have been used to measure high LET doses in patients being treated with negative pions. Measurements were made on the skin, in the oral cavity, and in the rectum of a series of patients and of certain selected patients. An analysis is given of the LET distribution of the particles observed in the thin, flat detector, and the high LET dose fraction is calculated from the event size spectrum. The data provide verification of the doses calculated from treatment planning. By timing the occurrence of the peak in the high LET dose distribution with respect to the position of the rangeshifter, one obtains the water-equivalent thickness of the bolus and tissues in front of the detector. This is the complementary measurement to the high LET dose measurement.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 24682, 24689, 24693, 24703, 24712, 24731

24726 Adsorption of enteroviruses to soil cores and their subsequent elution by artificial rainwater. Landry, E.F.; Vaughn, J.M.; Thomas, M.Z.; Beckwith, C.A. (Brookhaven National Lab., Upton, NY). *Appl. Environ. Microbiol.;* **38**: No. 4, 680-687(Oct 1979).

The adsorption and elution of a variety of human enteroviruses in a highly permeable, sandy soil was studied by using cores (43 by 125 mm) collected from on operating recharge basin on Long Island. Viruses studied included field and reference strains of poliovirus Types 1 and 3 and references strains of coxsackie virus B3 and echovirus Types 1 and 6. Viruses suspended in treated sewage effluent were allowed to percolate through soil cores, and the filtrate was assayed for unadsorbed viruses. To determine the likelihood of desorption and mobilization, soil-bound viruses were subjected to a rinse with either treated sewage effluent or simulated rainwater which reflected the anion, cation, and pH characteristics of a typical northeastern United States rainfall. The results demonstrated that all polioviruses tested, including both reference and field strains, adsorbed extremely well to cores. Adsorption was somewhat reduced when clen, unconditioned soils were used. Soil-bound poliovirus strain LSc was not significantly mobilized by flooding columns with either a sewage effluent or rainwater rinse. One virus was mobilized by both types of rinses. The amount of viruses mobilized by rainwater rinses ranged from 24 to 66%. Variable adsorption-elution results were observed with other enteroviruses. Two guanidine-resistant mutants of poliovirus LSc demonstrated a soil adsorption-elution profile different from that of the parent strain. The data support the conclusion that soil adsorption-elution behavior is strain dependent and the poliovirus, particularly strain LSc, represents an inappropriate model.

24727 Modified procedure for the recovery of naturally accumulated poliovirus from oysters. Vaughn, J.M.; Landry, E.F.; Vicale, T.J.; Dahl, M.C. (Brookhaven National Lab., Upton, NY). *Appl. Environ. Microbiol.;* **38**: No. 4, 594-598(Oct 1979).

Methods were compared for their ability to recover poliovirus from oysters (Crassostrea gigas) which had been allowed to accumulate virus via normal filtration activities. Clarification procedures included glycine-NaCl and polyelectrolyte extraction methods followed by a variety oi acid precipitation concentration methods. Polyelectrolyte flocculation followed by a beef extract-supplemented acid precipitation carried out at pH 3.5 yielded the most efficient recoveries. Direct assay of homogenates was found to be an unreliable method for determining the initial virus concentration in naturally infected oysters.

PATHOLOGY

REFER ALSO TO CITATION(S) 24691, 24703, 24727

24728 Race-specific molecules that protect soybeans from Phytophthora megasperma var. sojae. Wade, M.; Albersheim, P. (Univ. of Colorado, Boulder). *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 9, 4433-4437(Sep 1979).

Pnytophthora megasperma var. sojae (A. A. Hildebrand) is a fungal stem and root rot-causing pathogen of soybeans. Glycoproteins secreted into the medium of the aseptically cultured fungus have been partially purified by $(NH_4)_2SO_4$ precipitation and by column chromatography on norleucine-substituted Sepharose 4B and on DEAE-cellulose. Glycoprotein preparations from P. megasperma var. sojae races 1, 2, and 3 have been tested on four cultivars of soybeans. The partially purified glycoproteins from incompatible races of the pathogen (races that cannot successfully infect the plant), but not those from compatible races (races that can kill the plant), protect soybean seedlings from attack by compatible races. The seedlings are protected by introducing the glycoproteins into hypocotyl wounds of seedlings either 90 min prior to or at the time of inoculation of the wounds with mycelia of one of the pathogens. The glycoprotein preparations are poor nonspecific elicitors of phytoalexin accumulation; the glycoproteins have less than 1.0% of the elicitor activity of the glucans present in the mycelial walls of the pathogen.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 24687, 24690, 24694, 24728, 24771

24729 Absence of erythroblastic islands in plasma clot culture nd their possible reconstitution after clot lysis. Breton-Gorius, J.; Gui-

chard, J.; Vainchenker, W. (Hopital Henri Mondor, Creteil, France). *Blood Cells;* 5: 461-465(1979).

Ultrastructural studies of erythroid colonies derived from human peripheral blood and growing in plasma clot culture have confirmed the absence of a macrophage inside each colony of erythroblasts. However, when macrophages and erythroblasts were liberated from the semisolid media by clot lysis, these two types of cells rapidly acquired intimate contacts, suggesting the reconsitution of an erythroblastic island. The possible significance of this phenomenon is discussed.

24730 Haemopoietic stem cells: concepts and definitions. Lajtha, L.G. (Christie Hospital, Manchester, England). *Blood Cells;* 5: 447-455(1979).

A workshop was held, under the auspices of the UICC-ICREW Programme, at the Institut Gustave Roussy, Villejuif, France, on February 27, 1978. The aim of the workshop was to clarify some of the concepts, definitions, and abbreviations currently used in the field of haemopoietic stem cell research. It was thought to be unlikely at the onset that a complete and unanimous agreement could be reached on all issues. However, the summary text of the deliberations does indicate a considerable degree of consensus. Minority views, where clearly expressed, are included as such, as are discussion points on which no useful recommendations could be made.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 24695

PUBLIC HEALTH

REFER ALSO TO CITATION(S) 24726

24731 Survey of human enterovirus occurrence in fresh and marine surface waters on Long Island. Vaughn, J.M.; Landry, E.F.; Thomas, M.Z.; Vicale, T.J.; Penello, W.F. (Brookhaven National Lab., Upton, NY). *Appl. Environ. Microbiol.;* 38: No. 2, 290-296(Aug 1979).

A variety of surface water systems, including a lake, a creek, and two marine embayments, were analyzed on a monthly basis for indigenous human enteroviruses and coliform bacteria. Findings are discussed in terms of the probable pollution sources to each system and their relationship to data from previous studies.

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 23779, 23843, 24669, 24715, 24728

24732 (JPRS—74056) **Handbook on agricultural techniques for state farms.** (Joint Publications Research Service, Washington, DC (USA)). 22 Aug 1979. Translation of Guoying Nongchang Nongye Jishu Shouce, Shanghai, May 1975. 906p. NTIS, PC A99/MF A01.

The report contains information on Chinese agricultural techniques including seed propagation, crop rotation and cultivation and agricultural machinery.

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON BIOCHEMICALS

IN VITRO

24733 (DOE/EV/03221—61) **Chain inequivalence in bovine methemoglobin. Progress report, December 1, 1979-November 30, 1980.** Ilan, Y.A.; Ilan, Y.; Chevion, M.; Czapski, G. (Hebrew Univ., Jerusalem (Israel)). 1980. Contract AC02-76EV03221. 25p. NTIS, PC A02/MF A01.

Using pulse-radiolysis, a single-heme in the tetramer of bovine methemoglobin was reduced to the ferro state, producing a valence hybrid (VH). The kinetics of oxygen binding to the VH as well as the re-oxidation of the ferro-heme to the ferric state were studied as a function of pH. The kinetics of the oxygenation revealed the existence of two species, characterized by high and low affinities for oxygen that are associated with two quaternary structures (R and T, respectivey). Above pH 7.7 only the R state could be observed, while below pH 6.5 the T state was dominant. The reaction between the VH and ferricyanide at pH 7.75 (R state) consisted of two equal contributions attributed to the β and α subunits within the tetramer, respectively. At pH 6.3 (T state) a similar phenomenon was observed indicating chain inequivalences both in the T and the R states of methemoglobin. In the presence of inositol hexaphosphate, the T $\rightarrow$ R transition was shifted up by about 0.35 pH units. Yet similar rate constants exhibiting similar chain inequivalences have been measured.

24734 (DOE/EV/03221—62) **Does oxygen enhance the radiation: induced inactivation of penicillinase. Progress report, December 1, 1979-November 30, 1980.** Samuni, A.; Kalkstein, A.; Czapski, G. (Hebrew Univ., Jerusalem (Israel)). 1980. Contract AC02-76EV03221. 21p. NTIS, PC A02/MF A01.

The radiation-induced inactivation of penicillinase in dilute aqueous solutions buffered with phosphate was studied, by examining enzyme radiosensitivity in the presence of various gases (He, O_2, H_2, N_2O, N_2O + O_2). The introduction of either N_2O or O_2 was found to reduce the radiodamage. On the other hand H_2 or N_2O + O_2 gas-mixture enhanced the radiosensitivity. In the presence of formate and oxygen, no enzyme inactivation was detected. The results indicated that the specific damaging efficiency of H atoms is almost four-fold higher than that of OH radical; therefore in phosphate buffer, where more than half of the free radicals are H atoms, it is the H radicals that are responsible for the majority of the damage. The superoxide radicals appeared to be completely inactive and did not contribute toward enzyme inactivation. Oxygen was shown to affect the radiosensitivity in two ways. On one side, it protected by converting e^-/sub aq/ and H radicals into harmless O_2^- radicals. On the other side it increased the inactivation by enhancing the damage brought about by OH radicals (OER = 2.8). In the present case the oxygen effect of protection exceeded that of sensitization, thus giving rise to a moderate overall protection effect.

24735 (DOE/EV/03221—63) **Favism inducing agents: a pulse radiolysis study of isouramil and convicine.** Chevion, M.; Ilan, Y.A. (Hebrew Univ., Jerusalem (Israel)). 1980. Contract AC02-76EV03221. 16p. NTIS, PC A02/MF A01.

Isouramil and covicine, substances implicated in precipitating favic crises in glucose-6-phosphate dehydrogenase deficient individuals, have been studied in N_2O-saturated aqueous solutions by pulse radiolysis, and the kinetics of the reactions of both substances with OH radicals were determined. The products of these reactions are addition intermediates absorbing above 330 nm. The decay of the intermediate(s) formed in the isouramil reaction is a biphasic one, while the decay of the corresponding intermediate for the convicine reaction is characterized by a single constant. By analogy to uracil, it is suggested that the OH radical is added to the double bond at either positions 5 or 6 of the pyrimidine ring forming two different intermediates. Each of these intermediates loses a molecule of water indicated by the observed biphasic decay reaction. For convicine on the other hand, position 5 is blocked by the O-gucosidic bond and the addition of the OH radical could take place only at position 6. Thus, a single intermediate is formed and its decay is a single-phase one. It has been shown that although free radicals could not be detected in the course of the reactions between isouramil and oxygen or with cellular components by electron paramagnetic resonance, isouramil can participate in a uni-electron transfer reacton and can form relatively stable intermediates. Thus, it is speculated that in the red blood cells isouramil could give rise to deleterious free radicals.

IN MICROORGANISMS

REFER ALSO TO CITATION(S) 24744

IN MAN

REFER ALSO TO CITATION(S) 24778

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

24736 (UR—3490/LCP-20) **Analysis of the effects of chemical and physical mutagens on subchromosomal DNA synthesis in cultured mammalian cells.** Dahle, D.B. (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1980. Contract AC02-76EV03490. 245p. Dep. NTIS, PC A11/MF A01.

Thesis.

Subchromosomal DNA synthesis in Chinese hamster V-79 cells exposed to methyl methanesulfonate (MMS), x radiation, and ultraviolet (uv) radiation was investigated. The results indicate that these agents disturb DNA synthesis at the replicon level via two mechanisms of action, inhibition of replicon initiation or transient blockage of DNA chain growth. Exposure to uv or to MMS effects both DNA chain growth and initiation. In contrast, the depression in DNA synthetic rate in x-irradiated cells is due exclusively to inhibition of replicon initiation. For the most part, the damage inflicted upon the DNA synthetic apparatus produced by the three agents is

repairable. The inhibition of replicon initiation produced by each of the three agents studied appears to be a complex metabolic phenomenon, and speculation regarding several mechanisms by which replicon initiation may be inhibited is elaborated upon in the text. (ERB)

24737 Production and excision of thymine damage in the DNA of mammalian cells exposed to high-LET radiations. Mattern, M.R.; Welch, G.P. (Univ. of California, San Francisco). *Radiat. Res.;* **80**: No. 3, 474-483(Dec 1979).

HeLa S3 and Chinese hamster ovary cells were irradiated with high doses of carbon ions having linear energy transfers (LETs) of 170 and 780 keV/μm. The DNA was analyzed for 5,6-dihydroxydihydrothymine (t'-type) radiation products both before and after postirradiation incubation at 37°C. In HeLa cells, 2.1 x 10^{-5} ring-damaged thymines were produced per kilorad per 10^6 daltons after irradiation with high-LET carbon ions - approximately one-fifth the efficiency of t' formation in HeLa cells exposed to low-LET x rays. t' products were also formed less efficiently in Chinese hamster ovary cells exposed to carbon ions than in those exposed to x rays. In both cell lines, up to 80% of the t' formed initially was excised selectively from the DNA during 60 min of postirradiation incubation at 37°C. Product excision was accompanied by small amounts of DNA degradation (less than 1%). Radiation with LET of 170 keV/μm - nearly the most effective LET for cell killing and the generation of unrejoined DNA strand breaks - produced ring-damaged thymines that were removed selectively from the DNA. This result is consistent with the conclusion that t'-type products do not contribute substantially to lethality after high-LET irradiation, although the alternative possibilities remain that t' is not excised as efficiently after biological doses, or that a particular subclass of t' or defective postexcision events contribute to cell killing.

24738 Evidence for a change in the fluidity of erythrocyte membranes following x irradiation by measurement of pyrene excimer fluorescence. Yonei, S.; Todo, T.; Kato, M. (Kyoto Univ., Japan). *Radiat. Res.;* **80**: No. 3, 484-493(Dec 1979).

The changes in the fluidity of erythrocyte membranes following x irradiation were investigated with the aid of a fluorescent aromatic hydrocarbon, pyrene. The method used in the present experiments, pyrene excimer fluorescence, is based upon the microviscosity dependence of the lateral diffusion rate of the probe in the membrane plane. The lateral diffusion rate obtained by this fluorescence technique can provide valuable information about the fluidity of the membrane environment of the probe. It was found that the excimer/monomer ratio, a parameter of the lateral diffusion rate, of pyrene bound to erythrocyte membranes irradiated with x rays was higher than that in unirradiated membranes. This effect was observable when 100 R were given to the membranes. In addition, the fluorescence polarization of membrane-bound pyrene decreased in x-irradiated membranes. From these results it was concluded that x irradiation can induce an increase in the fluidity of the hydrocarbon regions of the membranes.

24739 Mutagenicity and cytotoxicity of 4.4-MeV α particles emitted by plutonium-238. Barnhart, B.J.; Cox, S.H. (Los Alamos Scientific Lab., NM). *Radiat. Res.;* **80**: No. 3, 542-548(Dec 1979).

The induction of mutation by α particles emitted by plutonium-238 (LET at the cell surface 100 keV/μm) and 250-kVp x rays has been measured utilizing the hypoxanthine-guanine phosphoribosyl transferase (HGPRT) locus in mammalian cells (CHO). Dose-response relationships for mutagenicity and survival of Chinese hamster cell line CHO are presented. Linear plots of mutations to 6-thioguanine resistance describe cumulative curves which reveal nonthreshold responses for both radiations. Although neither of these curves is linear over the entire range of doses shown, the initial portions of both curves are linear with non-zero slopes. The linear slopes for α- and x-ray-induced mutations are 4.79 +- 0.50 and 1.30 +- 0.23 x 10^{-7} mutations per viable cell per rad, respectively. However, plots of mutation frequency against survival show that for a given level of survival, α radiation is relatively less mutagenic than is x radiation.

24740 Oncogenic transformation of mammalian cells in vitro with split doses of x rays. Miller, R.C.; Hall, E.J.; Rossi, H.H. (Columbia Univ., New York, NY). *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 11, 5755-5758(Nov 1979).

An established line of mouse fibroblasts, C3H/10T1/2 cells, was used for the assessment in vitro of oncogenic transformations caused by single and split doses of x-rays. The shape of the dose-response relationship was determined over the range from 0.1 to 10 Gy. It was found that splitting the x-ray dose into two equal fractions, separated by 5 hr, led to a reduction in transformation frequency at doses above 1.5 to 2 Gy but to an enhancement of transformation at lower doses. The observations reported cast doubt on the assessment of human cancer risk at low dose levels by a linear extrapolation from available high-dose data from the Japanese atomic bomb survivors or from persons exposed for medical purposes.

24741 Deoxyribonucleic acid excision repair in chromatin after ultraviolet irradiation of human fibroblasts in culture. Williams, J.I.; Fredberg, E.C. (Stanford Univ. Medical Center, CA). *Biochemistry;* **18**: No. 18, 3965-3972(4 Sep 1979).

We have exposed confluent normal human fibroblasts to ultraviolet (UV) fluences of 5, 14, or 40 J/m^2 and monitored the specific activity of post-uv repair synthesis in chromatin with [^{3}H]thymidine pulses. We have shown that under conditions where no semiconservative deoxyribonucleic acid (DNA) synthesis is detectable, the specific activity of repair label one-fifth that in bulk DNA at all three uv fluences. On the other hand, the distribution of thymine-containing pyrimidine dimers in bulk and nuclease-resistant regions measured either immediately after irradiation or at later times showed no significant differences; preferential labeling of linker (nuclease-sensitive) DNA during repair synthesis is thus apparently not due to a predominance of uv-induced photoproducts in linker relative to core particle DNA in the nucleosoome. Pulse and pulse-chase experiments at 14 or 40 J/m^2 with normal human or repair-deficient xeroderma pigmentosum (XP) cells showed that at most 30% of repair label in all these cells shifts from nuclease-sensitive (linker) DNA to nuclease-resistant (core particle) DNA.

24742 Repair of ultraviolet light damage to the DNA of cultured human epidermal keratinocytes and fibroblasts. Taichman, L.B.; Setlow, R.B. (State Univ. of New York, Stony Brook). *J. Invest. Dermatol.;* **73**: No. 3, 217-219(1979).

Pure cultures of dermal fibroblasts and epidermal keroatinocytes have been obtained from a single biopsy of newborn foreskin. The cells were labeled, exposed to several doses of uv light, and allowed to repair in the dark for 16 h. The number of pyrimidine dimers before and after repair was assessed by measuring the numbers of sites in the DNA sensitive to a specific uv endonuclease. At all doses used, the extent of repair was similar in the cultured keratinocytes and cultured fibroblasts.

24743 Xeroderma pigmentosum variants have a slow recovery of DNA synthesis after irradiation with ultraviolet light. Cleaver, J.E.; Thomas, G.H.; Park, S.D. (Univ. of California, San Francisco). *Biochim. Biophys. Acta;* **564**: 122-131(1979).

Human cells (normal and xeroderma pigmentosum variant) irradiated with ultraviolet light and pulse-labelled with [^{3}H]thymidine underwent transient decline and recovery of molecular weights of newly synthesized DNA and rates of [^{3}H]thymidine incorporation. The ability to synthesize normal-sized DNA recovered more rapidly in both cell types than thymidine incorporation. During recovery cells steadily increased in their ability to replicate normal-sized DNA on damaged templates. The molecular weight versus time curves fitted exponential functions with similar rate constants in normal and heterozygous xeroderma pigmentosum cells, but with a slower rate in two xeroderma pigmentosum variant cell lines. Caffeine added during the post-irradiation period eliminated the recovery of molecular weights in xeroderma pigmentosum variant but not in normal cells. The recovery of the ability to synthesize normal-sized DNA represents a combination of a number of cellular regulatory processes, some of which are constitutive, and one of which is altered in the xeroderma pigmentosum variant such that recovery becomes slow and caffeine sensitive.

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

24744 (DOE/EV/03221—64) Contribution of endogenous and exogenous damage to the total radiation-induced damage in the bacterial spore. Jacobs, G.P.; Samuni, A.; Czapski, G. (Hebrew Univ., Jerusalem (Israel)). 1980. Contract AC02-76EV03221. 18p. NTIS, PC A02/MF A01.

Radical scavengers such as polyethylene glycol 4000 and bovine albumin have been used to define the contribution of exogenous and endogenous damage to the total radiation-induced damage in aqueous buffered suspensions of Bacillus pumilus spores. The results indicate that this damage in the bacterial spore is predominantly endogenous.

24745 Ultraviolet-induced reversion of cyc1 alleles in radiation-sensitive strains of yeast. III. rev 3 mutant strains. Lawrence, C.W.; Crhistensen, R.B. (Univ. of Rochester, NY). *Genetics;* **92**: No. 2, 397-408(Jun 1979).

The role of rev3 gene function in uv-induced mutagenesis in the yeast Saccharomyces cerevisiae has been examined by determining the reversion of 12 well-defined cyc1 mutations in diploid strains homozygous for the rev3-1 or rev3-3 allale. The 12 cyc1 alleles include one ochre, one amber, four initiation, two proline missense, and four frameshift mutations. We find that the rev3 mutations reduce the frequency of UV-induced reversion of all of the cyc1 alleles, though different classes of alleles respond to a different extent. These results imply that the rev3 gene function is required for

the production of a wide variety of mutational events, though probably not all, and show that each of the three rev loci have different mutational phenotypes. Such diverse phenotypes are not predicted by the unitary model for bacterial mutagenes, suggesting that this is at best an incomplete description of eukaryotic mutagenesis.

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 23704, 24628

24746 Results of a pilot study with extended fractionation in the treatment of lung cancer. Mohiuddin, M.; Rouby, E.; Kramer, S. (Thomas Jefferson Univ. Hospital, Philadelphia, PA). *Int. J. Radiat. Oncol., Biol. Phys.;* **5**: No. 11-12, 2039-2042(Nov 1979).

An extended fractionation schedule delivering 6600 rad in 10 weeks was used in a pilot study on thirty patients with squamous carcinoma of the lung. Local tumor response and normal tissue reactions were assessed. Greater than 50% regression of tumor occurred in 27/30 (90%) of patients; seven of these had a complete response. Only three patients developed symptomatic pneumonitis. Compared with Other published reports using conventional fractionation, the local response with this extended fractionation appears better; it is tolerated exceedingly well with few side effects.

VERTEBRATES

REFER ALSO TO CITATION(S) 24740

24747 Oxygen effect and adaptive reactions of cells. Report 2. Kinetics of respiration of tumor cells differing in initial respiration level. Voloshina, E.A.; Vygodskaya, A.L.; Epshtein, I.M.; Yarmonenko, S.P. (Oncological Research Center, Moscow, USSR). *Radiobiology (USSR) (Engl. Transl.);* **18**: No. 4, 69-74(Mar 1979).

Translated from Radiobiologiya; 18: No. 4, 540-544(1978).

The polarographic method was used to investigate the kinetics of oxygen uptake by cells of Ehrlich's ascites carcinoma (EAC) at different times after inoculation thereof. It was demonstrated that the level of initial oxygenation of cells affects the intensity of cellular respiration and relation thereof to pO_2 of the extracellular medium. Analysis of amperochronograms leads to the conclusion that there is an increase in O_2 permeability of the cytoplasmic membrane with growth of EAC and increase in hypoxia of the tumor. The obtained data, as related to experiments that demonstrated attenuation of the radiomodifying effect of acute hypoxia on EAC cells with a low base level of oxygenation, are discussed from the standpoint of the adaptation hypothesis.

24748 Induction of lung tumors in RFM mice after localized exposures to x rays or neutrons. Ullrich, R.L.; Jernigan, M.C.; Adams, L.M. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Radiat. Res.;* **80**: No. 3, 464-473(Dec 1979).

The purpose of the present study was to compare the dose-response relationships for the induction of lung tumors in RFM mice after localized thoracic exposures to x rays or fission neutrons. Animals were killed 9 months after localized irradiation, their lungs were cleared, and the tumors were counted to determine both percentage incidence and tumors/mouse. From these data, the relationship between tumors/mouse and x-ray dose could be described adequately by a linear-quadratic model with a shallow initial slope, or by a threshold model with a dose-squared response above the threshold dose, and linearity could be rejected over the dose range of 0 to 900 rad. For neutrons the relationship between tumors/mouse and dose over the range of 0 to 25 rad could be described by a linear, or a threshold model with linear response above the threshold. In either case, the relative biological effectiveness increased with decreasing neutron dose from 25 at 25 rad to 40 at 10 rad.

24749 Synergism of diethylstilbestrol and radiation in mammary carcinogenesis in female F344 rats. Holtzman, S.; Stone, J.P.; Shellabarger, C.J. (Brookhaven National Lab., Upton, NY). *J. Natl. Cancer Inst.;* **63**: No. 4, 1071-1074(Oct 1979).

One compressed 20-mg pellet containing cholesterol only or chlesterol mixed with 0.98, 1.6, 2.6, or 3.9 mg of diethylstilbestrol (DES) was implanted into each of 203 female F344 rats. Two days later, half the animals in each group were exposed to 150 R of x-ays, and the other half were sham irradiated. The rats were maintained until 350 days post implantation. Mortality increased with the higher doses of DES, with or without x-rays. DES at all dose levels, with or withoug x-rays, produced pituitary tumors and pyometritis. Only rats that received both DES and x-rays had mammary adenocarcinomas (AC). A synergistic AC response was found in the group that received 2.6 mg DES plus x-rays. Synergism was defined as a significantly greater incidence of rats with mammary neoplasia resulting from DES plus x-ray treatment when compared to the summed incidence from comparable individual treatments. For all other groups of rats that received both treatments. For all other groups of rats that received both treatments, synergism was detected only when their data were combined. Synergism was not detected among rats that had fibroadenomas (FA). Both types of neoplasma were independent phenomena because no significant relationship was found between the incidences of FA and AC.

24750 Analysis of the albino-locus region of the mouse. III. Time of death of prenatal lethals. Russell, L.B.; Raymer, G.D. (Oak Ridge National Lab., TN). *Genetics;* **92**: No. 1, 205-213(May 1979).

The stage at which homozygotes die was determined for 28 mutations (general symbol c*) at the albino (c) locus, of which 26 had earlier been found to be probably prenatally lethal. Within each of the mutant stocks, the uterine contents of c*/c/sup ch/ females, made pregnant either by c*//c/sup ch/ males (Ex series) or by c/sup ch//c/sup ch/ males (Co series), were examined between 13 and 17 days postconception. Altogether, 743 females were dissected and 7197 corpora lutea (representing ovulations) counted. In selected stocks, an additional 40 and 13 females were dissected on days seven or nine, respectively. In each of the 26 presumed prenatally lethal mutants, there was a deficiency of living fetuses in the Ex, as compared with the Co, group. Overall, this deficiency was 23.6% (expectation, 25% c*/c*). All meaningful excesses were in numbers eigher of moles (death shortly before, during, or just after implantation), or of early preimplantation losses. Homozygotes in none of the mutant stocks die between days nine and 19 postconception. Of 24 c-locus mutants known to be deficiencies since they lack the closely linked Mod-2, 13 clearly kill before implantation, ten around implantation, and one neonatally. The c and Mod-2 loci and the region between them are not needed for intrauterine survival. There are indications that the distinction between early-preimplantation death and implantation death may, in a general way, be related to length of the deficiency.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

REFER ALSO TO CITATION(S) 24632

ANIMALS

24751 (DOE/EV/02874—68) **Osteosarcomas among beagles exposed to ^{239}Plutonium. Technical report No. 34.** Whittemore A.S.; McMillan, A. (Stanford Univ., CA (USA). Dept. of Statistics). Mar 1980. Contract AC02-EV02874. 30p. NTIS, PC A03/MF A01.

A Weibull distribution was fit to the osteosarcoma death times of beagles given single intravenous injections of ^{239}Pu. For injected doses in the range 0 to 1 μCi/kg the osteosarcoma incidence rate h(t) at t days after injection can be fit by a quadratic function of the injected dose. The best fitting linear function was rejected by the data ($p < 0.001$). A different formula for h(t), derived from amultistage theory for osteosarcoma induction, was also fit to these data. For this purpose microdosimetry calculations were used to estimate the dose to the cells at risk in the endosteal layer (endosteal dose). According to the best fit, h(t) is a quadratic function of endosteal dose at low doses. A linear dose-response relationship was agan rejected. The absence of a linear component at low doses might be explained by the fact that 108 of the 185 animals injected at the lowest doses (< 0.02 μCi/kg) were still alive at the time these data were collected.

NUCLIDE KINETICS AND TOXICOLOGY

MAN

REFER ALSO TO CITATION(S) 24631, 24632, 24755

24752 (COO—3382-18, pp III.1-III.12) **Metabolism of americium-241 in man: an unusual case of internal contamination of a child and his father.** Cohen, N.; Sasso, T.L.; Wrenn, M.E. 30 Jun 1979.

In Radioactivity studies progress report.

The metabolism of americium-241 was studied during an 8-yr period of an adult male and his son who, at the ages of 50 and 4, respectively, were accidentally and unknowingly contaminated within their home by means of inhalation. Chelation therapy with Na_5(Ca-DTPA) was more effective in enhancing the removal of americium-241 from the child than from his father.

24753 (COO—3382-18, pp VII.1-VII.12) **Improved mathematical model for uranium metabolism.** Lipsztein, J.; Wrenn, M.E.; Cohen, N. 30 Jun 1979.

In Radioactivity studies progress report.

An improved mathematical model for uranium metabolism in the primate was developed. Animal and human literature data were the basis for building the model consisting of six compartments: plasma, red cells, short-term bone component, long-term bone component, kidney, and urine. In this model, there is a feedback from the red cells and bone compartments to plasma, and the model is applicable to uranium only from the time it is absorbed into blood. An analytical mathematical solution is proposed that will permit estimation of the distribution of uranium among the various compartments. To verify the model and determine the required time constants, single non-toxic doses of uranium were administered to baboons and plasma, red cells, and urine samples subsequently analyzed. Samples of human skeleton were also measured for normal levels of uranium. These measurements will be used to test whether the model accurately predicts long-term bond concentration. Uranium exists in the mammalian body as the hexavalent uranyl ion which tends to complex with plasma proteins or bicarbonates. Animal experiments indicate that after an iv injection, uranium leaves the bloodstream very rapidly; at 40 min after injection, 50% has been excreted in the urine, with little uranium in tissue other than kidney and bone. The distribution of uranium in humans is similar to that in animals. There was no significant concentration of uranium in any of 21 human tissues and organs, apart from bone and kidney, examined at autopsy. (ERB)

24754 (PNL—3209) **PABLM: a computer program to calculate accumulated radiation doses from radionuclides in the environment.** Napier, B.A.; Kennedy, W.E. Jr.; Soldat, J.K. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1980. Contract EY-76-C-06-1830. 205p. NTIS, PC A10/MF A01.

A computer program, PABLM, was written to facilitate the calculation of internal radiation doses to man from radionuclides in food products and external radiation doses from radionuclides in the environment. This report contains details of mathematical models used and calculational procedures required to run the computer program. Radiation doses from radionuclides in the environment may be calculated from deposition on the soil or plants during an atmospheric or liquid release, or from exposure to residual radionuclides in the environment after the releases have ended. Radioactive decay is considered during the release of radionuclides, after they are deposited on the plants or ground, and during holdup of food after harvest. The radiation dose models consider several exposure pathways. Doses may be calculated for either a maximum-exposed individual or for a population group. The doses calculated are accumulated doses from continuous chronic exposure. A first-year committed dose is calculated as well as an integrated dose for a selected number of years. The equations for calculating internal radiation doses are derived from those given by the International Commission on Radiological Protection (ICRP) for body burdens and MPC's of each radionuclide. The radiation doses from external exposure to contaminated water and soil are calculated using the basic assumption that the contaminated medium is large enough to be considered an infinite volume or plane relative to the range of the emitted radiations. The equations for calculations of the radiation dose from external exposure to shoreline sediments include a correction for the finite width of the contaminated beach.

ANIMALS

REFER ALSO TO CITATION(S) 24753

24755 (COO—3382-18) **Radioactivity studies progress report.** Cohen, N.; Wrenn, M.E. (New York Univ., NY (USA). Inst. of Environmental Medicine). 30 Jun 1979. Contract EY-76-S-02-3382. 104p. NTIS, PC A06/MF A01.

Separate abstracts were prepared for the 7 individual sections included in this progress report. (ERB)

24756 (COO—3382-18, pp I.1-I.29) **Distribution and retention of ^{243}^{4}Cm in the adult baboon.** Sasso, T.L.; Cohen, N.; Wrenn, M.E. 30 Jun 1979.

In Radioactivity studies progress report.

The metabolism of ^{243}^{4}Cm-citrate was studied in six adult female baboons for up to 26 months post intravenous injection. In vivo measurements employing gamma scintillation detectors in conjunction with whole-body and partial-body counting techniques were used to estimate deposition and retention for the total body and specific organ sites. In addition, ^{243}^{4}Cm concentrations were measured in urine, feces, blood, and biopsy samples of liver. Curium-243,4 leaves the blood rapidly with 0.7% of the injected dose present in the blood at 24 hrs after injection. The primary sites of deposition are skeleton (≃ 60%) and liver (≃ 20%) at early times. The retention of ^{243}^{4}Cm in bone has a half-life of several years, while that in liver is approximately 40 days. Approximately 7% of the injected dose is excreted in the urine during the first 24 hrs. Curium-243,4 eliminated from the liver appears to be predominantly excreted with the feces as is the case for ^{241}Am.

24757 (COO—3382-18, pp II.1-II.21) **Curium-243,4 in the tissues of the adult baboon.** Sasso, T.L.; Cohen, N.; Wrenn, M.E. 30 Jun 1979.

In Radioactivity studies progress report.

The curium content of the soft tissues and skeletons of six baboons (serially sacrificed at 3, 7, and 26 months post exposure) was determined in order to define the changing distribution of ^{243}^{4}Cm with time post intravenous injection. The efficacy of a DTPA treatment regimen was also investigated as a function of time of initiation of decorporation post injection of curium. Administration of DTPA treatment was begun at either 0.6, 1.5, or 8 months post exposure.

24758 (COO—3382-18, pp IV.1-IV.6) **Microdistribution of ^{243}^{4}Cm in the ovary of an adult baboon.** Cohen, N.; Kreitman, B.; Sasso, T.L.; Guilmette, R.A.; Neton, J.; Wrenn, M.E. 30 Jun 1979.

In Radioactivity studies progress report.

Studies are currently underway to define the distribution of ^{243}^{4}Cm in tissues of the adult baboon. The results of these investigations are not yet complete, however, the specific loci of deposition for curium in the ovary was of sufficient interest and contained dosimetric implications which warrant this preview of a more complete description. Therefore, a brief description of the autoradiographic results obtained in sections of the left ovary of a representative adult baboon injected with ^{243}^{4}Cm is presented.

24759 (COO—3382-18, pp V.1-V.6) **Cross-placental transfer of ^{243}^{4}Cm in the baboon.** Neton, J.; Sasso, T.L.; Cohen, N.; Wrenn, M.E. 30 Jun 1979.

In Radioactivity studies progress report.

An adult female baboon was injected with 1.36 μCi ^{243}^{4}Cm approximately four months after the onset of pregnancy. Forty-five days subsequent to the injection, the fetus was delivered by Caesarean section and the individual organs assayed for their ^{243}^{4}Cm contents. The soft tissues, placenta and skeleton were found to contain 0.03, 1.11, and 0.42% respectively of the mother's body burden.

24760 (COO—3382-18, pp VI.1-VI.7) **Short term kinetics of uranium in the adult baboon: preliminary data.** Neton, J.; Sasso, T.L.; Lipsztein, J.; Wrenn, M.E.; Cohen, N. 30 Jun 1979.

In Radioactivity studies progress report.

Two adult female Kenya baboons received single intravenous injections of monomeric ^{237}U nitrate. The doses administered were 4.21 μCi ^{237}U. The retention and distribution were followed in the two baboons at predetermined intervals post-injection. Retetion and distribution curves were plotted over the intervals from 3 to 44 days post-injection. Analysis of the head counting data revealed that after nine days post-injection the short-term clearance from the skull (bone) could be expressed by an exponential function with a mean half time of 55 days with individual t/sub 1/2/ values of 69.3 and 41.0 days. The short-term t/sub 1/2/ is apparently due to the initial ion exchange capabilities of the skeletal surface while the longer-term component represents uranium which has become incorporated into skeletal structures. In order to investigate the long-term component, a longer-lived isotope of uranium ^{233}U was used. The whole body mean biological half-life of ^{237}U was calculated to be 25.9 +- 8.8 days. The kidney measurements were fitted to a two exponential curve with mean half times of 6.8 +- 4.0 and 45.4 +- 18.8 days. The liver measurements were inconclusive probably due to the fact that uranium is not known to concentrate in the liver to any extent. (ERB)

THERMAL EFFECTS

REFER ALSO TO CITATION(S) 24778

MICROORGANISMS

24761 **Entrainment.** Carrier, R.F. (Oak Ridge National Lab., TN). *J. Water Pollut. Control Fed.;* 1567-1582(Jun 1978).

The studies reviewed in this report are of two types: (1) reviews, including theoretical studies concerned with the development of methodology to determine the ultimate significance of entrainment effects to whole populations and ecosystems, and (2) site and laboratory studies concerned primarily with the number of aquatic organisms entrained through power plant cooling systems, the specific causes of entrainment, and the physical and biological effects on the organisms. The references have been drawn from the 1976 and 1977 literature.

INVERTEBRATES

REFER ALSO TO CITATION(S) 24761

VERTEBRATES

REFER ALSO TO CITATION(S) 24761, 24773

CHEMICALS METABOLISM AND TOXICITY

CELLS

REFER ALSO TO CITATION(S) 24736, 24765

24762 (CONF-791059—6) **Reproductive survival and macromolecular synthesis in cultured mammalian cells exposed to single metabolites and mixtures of metabolites of benzo(a)pyrene.** Griffin, G.D.; Dudney, C.S.; Furcinitti, P.S.; Jones, T.D.; Walsh, P.J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 27p. Dep. NTIS, PC A03/MF A01.

From 4. international symposium on polynuclear aromatic hydrocarbons; Columbus, OH, USA (2 Oct 1979).

Chinese hamster V79 cells have been exposed to single metabolites and mixtures of metabolites of benzo(a)pyrene [B(a)P] and reproductive cell survival and certain aspects of cellular metabolism were measured. B(a)P trans-7,8-dihydrodiol plus B(a)P 1,6-quinone resulted in increased cell survival compared to treatment with either metabolite alone, the mixture thus producing a neutralizing effect. If B(a)P 4,5-oxide is mixed with 3-HOB(a)P, increasing amounts of 3-HOB(a)P do not cause any additional cell toxicity. When replicate cultures of V79 cells were exposed to either B(a)P 4,5-oxide or 6-HOB(a)P for 4, 12, or 48 h, there was an exposure-time-dependent delay in cell division, the effect being most pronounced for 48 h exposure to 6-HOB(a)P. After the division delay, cells resumed an apparently normal exponential growth rate. A larger percentage of metabolite-treated cells were cycling after treatment, than was the case with control cells, even though the exponential growth rate was similar in both sets. RNA synthesis increased above control levels after removal of the metabolite, particularly in the case of 6-HOB(a)P. Protein synthesis was inhibited by 6-HOB(a)P addition, and after metabolite removal, increased to control levels concomitantly with RNA synthesis. The results suggest that metabolite treatment causes at least a temporary cell-cycle delay. After the metabolite is removed, protein synthesis mechanisms rebound to increase protein synthesis. (ERB)

24763 (CONF-7910146—1) **Screening for mutagenic response of six coded chemicals in the CHO/HGPRT system.** Hsie, A.W.; O'Neill, J.P.; Machanoff, R.; Schenley, R.L.; Brimer, P.A. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

From International program for the evaluation of short-term tests for carcinogenicity; St Simons, GA, USA (16 Oct 1979).

A set of stringent conditions required for quantifying mutation-induction to 6-thioguanine resistance, which selects for > 98% variants with altered hypoxanthine-guanine phosphoribosyl transferase (HGPRT) activity in a near-diploid Chinese hamster ovary (CHO) cell line have been defined. The system fulfills criteria for a specific locus mutational assay and is useful in studies of mechanisms of mammalian cell mutagenesis, determination of the mutagenicity of various physical and chemical agents, and screening for mutagenic activity of some industrial chemicals. Preliminary findings on the application of this system in screening for the mutagenic activity of 6 coded chemicals supplied by the International Program for the Evaluation of Short-Term Test for Carcinogenicity are presented. The study limits itself to concerns more with mutagenic response than quantitative mutagenesis. Although our limited study of 6 out of 42 chemicals in no way could be used for evaluating the performance of the CHO/HGPRT system; nevertheless, it could shed some light on identifying certain considerations necessary for applying this system for screening the mutagenic activity of unknown chemicals.

24764 **Unstable, non-mutational expression of resistance to the thymidine analogue, trifluorothymidine in CHO cells.** Adair, G.M.; Carver, J.H. (Univ. of California, Livermore). *Mutat. Res.;* **60**: 207-213(1979).

The thymidine analogue, 5-trifluoromethyl-2'-deoxyuridine, or trifluorothymidine (TFT), has been reported to be an effective selecting agent for thymidine kinase-deficient (TK^-) mutants in a mutagenesis assay system employing a tk^{+-} heterozygote of L5178Y mouse lymphoma cells. Although 5-bromo-2'-deoxyuridine (BUdR) and 5-iodo-2'-deoxyuridine (IUdR have been commonly used to select TK^- mutants, considerable cell division and slow killing of wild-type (WT) cells occur in the presence of these drugs. TFT, however, rapidly inhibits cell division, and unlike BUdR and IUdR, is not mutagenic in mammalian cells. All three analogues are mutagenic in T4. TFT is readily phosphorylated by thymidine kinase (TK), competitively inhibiting utilization of the normal substrate. The phosphorylated derivative of TFT is a potent, irreversible inhibitor of thymidylate synthetase. Further phosphorylation to the di- or tri-phosphates and incorporation into the DNA of mammalian cells in culture have also been demonstrated.

MICROORGANISMS

24765 (CONF-790663—3) **Mutagenicity testing of aqueous materials from alternate fuel production.** Rao, T.K.; Larimer, F.W.; Nix, C.E.; Epler, J.L. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 17p. Dep. NTIS, PC A02/MF A01.

From Symposium on analysis of waters associated with alternate fuel production; Pittsburgh, PA, USA (4 Jun 1979).

In a multidisciplinary effort, we are attempting to establish a data base for toxicity evaluation of a variety of aqueous effluents and aqueous extracts from solid wastes from fossil fuels, synthetic fuels, and shale oil-derived fuels. In genetic toxicology testing, short-term mutagenicity tests, including bacterial, fungal, insect, and mammalian cell systems, have been applied in a comparative sense to exemplary test materials. The Salmonella histidine reversion assay (Ames' test) has been shown to be generally applicable especially when utilized with chemically fractionated materials. Liquid-liquid extraction and column chromatography are used to separate crude test materials into defined fractions for bioassay paralleled by chemical analyses. Test materials have included various crude oils and product waters along with extracts from raw shale and processed shale. Mutagenic materials have been observed and quantitated. Extrapolations to specific compounds and to the overall biohazard of the test materials are in progress. Comparative studies with samples from existing petroleum technologies and fossil fuel processes are being carried out.

24766 **Photodynamic effects of dyes on bacteria. I. Mutagenesis by acridine orange in the dark in excision- and recombination-deficient strains of Escherichia coli.** Hass, B.S.; Webb, R.B. (Argonne National Lab., IL). *Mutat. Res.;* **51**: 279-284(1978).

Reported are the mutation rates of Excherichia coli strains both proficient and deficient in excision and recombination DNA-repair functions as effected by the dye acridine orange. The recombination-deficient and excision-deficient strains produce spontaneous mutation rates lower than that of wild-type strains except in the presence of acridine orange when the same repair-deficient strains showed higher mutation rates than the wild-type strain. (DS)

PLANTS

REFER ALSO TO CITATION(S) 23664, 24777

24767 (PB—300460) **Remote sensing of sulfur dioxide effects on vegetation - photometric analysis of aerial photographs.** Sapp, C.D. (Tennessee Valley Authority, Chattanooga (USA). Office of Natural Resources). Jun 1979. 41p. NTIS, PC A03/MF A01.

Spectral reflectances were measured by tri-band densitometry of aerial color-infrared photographs of soybean (Glycine mas fields that had been affected by sulfur dioside (SO_2) emissions from large, coal-fired power plants in northwestern Alabama and western Tennessee. The photographs were photometriacally calibrated. Results indicate that, at very light levels of foliar injury, the infrared-to-red reflectance ration decreased with increasing injury. This behavior was in accordance with theory. However, at moderate and severe levels of injury, the ratio increased with injury. The best indicator of crop yield was green band reflectance, but the red and infrared bands were nearly as good. The yield variable actually increased with the level of injury, apparently because of field-to-field variations in canopy density.

24768 **Plant developmental system to measure the impact of pollutants in rain water.** Evans, L.S. (Brookhaven National Lab., Upton, NY). *J. Air Pollut. Control Assoc.;* **29**: No. 11, 1145-1148(Nov 1979).

Fertilization and spermatozoid motility in gametophytes of bracken fern (Pteridium aquilinum) are very sensitive to low pH and additions of sulfate, nitrate, and chloride. Spermatozoid motility at pH levels 6.0, 5.5, and 5.1 was about 70%, 50%, and 30%, respectively, of values obtained at pH 6.1, 2 to 4 minutes after exposure. Motility at sulfate concentrations of 43.3, 86.6, and 173.2 μM was about 60%, 45%, and 35%, respectively, of values obtained at pH 6.1. Fertilization decreased as the pH decreased below pH 6.1. Fertilization after 3.5 hr exposure to pH 5.5, 5.1, and 4.5 was about 90%, 75%, and 60%, respectively, of values obtained at pH 6.1. Fertilization values at sulfate concentrations of 43.3, 86.6, and 173.2 μM were about 85%, 75%, and 60%, respectively, of values obtained at pH 6.1. Based upon these results, fertilization in bracken fern may be a good indicator of pollutants in rainwater.

24769 **Effects of divalent metal chlorides on respiration and extractable enzymatic activities of douglas-fir needle litter.** Spalding, B.P. (Corvallis Environmental Research Center, OR). Contract W-7405-ENG-26. *J. Environ. Qual.;* **8**: No. 1, 105-109(Jan 1979).

The rates of CO_2 evolution from Douglas-fir (Pseudotsuga menziesii {Mirb.] Franco) needle litter, following application of divalent metal (Hg, Cd, Pb, Ni, Zn, and Cu) chlorides at rates of 10, 100, and 1000 μg/g and Ca chloride at 7, 68, and 683 μg/g, were monitored at 2- to 3-day intervals for 4 weeks; extractable enzymatic activities were also measured on additional samples at 1 day, 2, and 4 weeks following treatment. All metals except Pb inhibited respiration when applied at the highest level. Cellulase activity was depressed by treatments of 1000 μg/g of either Hg or Cd after 4 weeks but was not affected initially (1 day after). After 4 weeks, xylanase activity was also depressed by the 1000-μg/g Hg treatment. Apparently these enzymatic activities declined due to decreased enzyme synthesis associated with inhibited microbial growth rather than by direct enzymatic inhibition. Although addition of Hg or Cu chlorides directly to litter extracts caused marked inhibition of most enzymatic activities, equivalent levels, when applied to the needle litter, produced no inhibitions in extracts after 1 day, except for invertase activity. Invertase activity was depressed at all intervals and β-glucosidase activity was elevated at all intervals by Hg at the 1000-μg/g level. The level of extractable ninhydrin-reactive compounds was elevated by this Hg treatment at all intervals similar to the effect of fumigation of soil or litter. Regardless of treatment, cellulase and xylanase activities were correlated ($r = 0.70$, $n = 192$).

INVERTEBRATES

REFER ALSO TO CITATION(S) 24765

24770 (UCRL—52932) **Examination of the effects of 50 ppB copper on the black abalone, Haliotis cracherodii.** Yaffe, P.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Oct 1979. Contract W-7405-ENG-48. 47p. NTIS, PC A03/MF A01.

The short-term uptake of copper by the black abalone, Haliotis cracherodii, was studied to determine the toxic effects of copper on these animals. Radioactive copper-64 was used as a tracer in both a control aquarium, which contained seawater with the natural background level of 5 ppB copper, and an experimental aquarium, which contained the same seawater plus an additional 50 ppB copper as copper sulfate. A total of 18 abalone were used, 9 in each aquarium. Three abalone were removed and dissected at each sampling time. The data obtained from two analytical methods were compared to identify trends of copper accumulation in certan tissues. The most likely cause of death of abalone exposed to elevated copper concentrations (e.g., 50 ppB) is suffocation due to mucus smothering the gills. Also, abalone blood does not appear to absorb much excess copper. The kidney accumulates some copper, as does the gonad. Accumulation of copper in the gonad could have deleterious effects on the gamates. In addition, the digestive gland appears to be the organ of storage for heavy metals; this tissue can accumulate copper to concentrations almost 100 times greater than in any of the other tissues.

VERTEBRATES

REFER ALSO TO CITATION(S) 23648, 24777

24771 (UR—3490-1798) **Lead transfer in maternal milk, and the absorption, retention, distribution and excretion of lead in suckling mice.** Keller, C.A. (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1980. Contract AC02-76EV03490. 219p. Dep. NTIS, PC A10/MF A01.

Thesis.

Suckling mice were found to absorb and retain a greater fraction of an oral lead dose than did adult mice. Pinocytotic activity and lead uptake (in vivo) were found to be greatest in the distal small intestinal tissue. Cortisone pretreatment results in precocious cessation of pinocytotic activity in the intestine of suckling mice. Cortisone pretreatment of adult mice had no effect on whole body lead retention or intestinal tissue content of lead following an oral dose. The data indicate that the distal small intestine is the site of active pinocytosis of lead, and that pinocytosis is the major mechanism involved in lead absorption in suckling mice. Developmental differences were also observed in the percentage of lead retained in the whole body. Both groups exhibited dose-independent lead retention, indicating a first-order absorption process for each age group. Lead distribution and elimination from organs also differed between suckling and adult mice. Developmental differences were observed in organ lead concentration for kidneys and brain following oral doses. Relative distribution of lead to the brains of suckling mice were greater than to adult brains. Whole body and bone lead elimination rates were reduced in suckling compared to adult mice. Brain lead elimination rates did not differ in suckling and adult mice. A lactating mouse model was developed to study lead transfer to suckling offspring. Lead was transferred in milk to suckling offspring from mothers which had previously ingested lead in the drinking water. Relative lead transfer to suckled offspring during lactation greatly exceeded transfer to fetuses during gestation. Lactation resulted in an increased rate of maternal lead elimination. Lead concentration in milk exceeded plasma concentration by a factor of approximately 25. (ERB)

24772 Distribution and excretion of lead in young and adult female mice. Keller, C.A.; Doherty, R.A. (Univ. of Rochester, NY). *Environ. Res.;* **21**: No. 1, 217-228(Feb 1980).

The kinetics of whole body lead elimination and organ distribution were studied in 10-day-old and adult female mice following a single dose of lead. Necropsies were performed periodically during the 50-day experiment to assess organ lead distributions and lead elimination. Between Days 15 and 50 excretion of lead was found to occur nearly equally through urinary and fecal routes. Whole body lead retention during the terminal elimination phase was observed to have a half-time similar to that of lead retained in femur. Rates of lead elimination from femur and from whole body of young mice were apparently less rapid than comparable elimination rates in adult mice. Lead fluxes from the brains of young and adult mice were closely approximated by single component exponential equations. The results suggest that a three-compartment model does not adequately account for the kinetics of lead distribution and retention in mouse brain after a single dose.

24773 Effect of tetracycline hydrochloride treatment on the critical thermal maximum of common shiners. Contract EY-76-C-09-0819. *Prog. Fish-Cult.;* **42**: No. 1, 48-49(Jan 1980).

The transfer of fish from field to laboratory facilities or their propagation in closed or restricted systems frequently results in bacterial infection and ultimately large-scale mortality. In attemps to alleviate this problem, we have added tetracycline hydrochloride to the water prophylactically (pretreating tanks before wild fish were added) and therapeutically (treating tanks after bacterial outbreaks were detected.) In the present study, we examined the effect of tetracyline hydrochloride on the critical thermal maximum (CTM) of the common shiner (Notropis cornutus).

24774 Specific-locus test shows ethylnitrosourea to be the most potent mutagen in the mouse. Russel, W.L.; Kelly, E.M.; Hunsicker, P.R.; Bangham, J.W.; Maddux, S.C.; Phipps, E.L. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 11, 5818-5819(Nov 1979).

Use of the specific-locus test to measure the frequency of transmitted gene mutations induced in mouse spermatogonia has shown ethylnitrosourea to be by far the most potent mutagen yet discovered in the mouse. The dose used, 250 mg/kg, gave a mutation rate 5 times as high as had been obtained with 600 R, the most effective acute dose of x rays. Compared to procarbazine, heretofore the most mutagenic chemical known in the mouse, ethylnitrosourea proved to be 15 times more mutagenic than the peak effect obtained with the most effective dose of procarbazine. Because of its high mutagenicity, ethylnitrosourea can serve as a model compound in exploring the effect of such factors as dose response, dose fractionation, sex, and cell stage on the mutagenic action of a chemical. Ethylnitrosourea is clearly the mutagen of choice for the production of any kind of desired new gene mutations in the mouse.

24775 Metals in soft tissues of mule deer and antelope. Munshower, F.F.; Neuman, D.R. (Montana State Univ., Bozeman). *Bull. Environ. Contam. Toxicol.;* **22**: No. 6, 827-832(Aug 1979).

The Northern Great Plains is one of the few remaining areas in the United States containing large numbers of free roaming big game animals. Because of increasing fossil fuel development in this region and the potential for trace metal environmental hazards associated with this development, a closer look at metal levels in wildlife is desirable. The effect of elevated concentrations of trace metals upon laboratory animals, fish and man have been studied and many articles and reviews published but almost nothing has been said of increases in trace metals in the diets or tissues of wild terrestrial herbivores. In only a few cases has mention even been made of the levels of different elements in wildlife tissues. Most heavy metals are selectively concentrated in the liver and kidneys. These organs are, therefore, the preferred heavy metal reservoirs in studies of animal burdens and were used in this investigation.

MAN

REFER ALSO TO CITATION(S) 24602

24776 (DOE/EV/02874—69) **Asthma and air pollution in the Los Angeles area. Technical report No. 35.** Whittemore, A.S.; Korn, E.L. (Stanford Univ., CA (USA). Dept. of Statistics: California Univ., San Diego, La Jolla (USA). Dept. of Physics). Mar 1980. Contract AC02-76EV02874. 35p. NTIS, PC A03/MF A01.

Daily asthma attack diaries of sixteen panels of asthmatics residing in the Los Angeles area were collected by the Environmental Protection Agency for 34 week periods during the years 1972 to 1975. These data are examined here for the relationship between daily attack occurrence and daily levels of photochemical oxidant,

total suspended particulates, minimum temperature, relative humidity, and average wind speed. A separate multiple logistic regression is used for each panelist's attack data. Variables representing the presence or absence of attack on the preceding day, as well as day of week and time since the start of the study, are included in the regressions. The most significant predictor of attacks was the presence of an attack on the preceding day. On the average, the panelists tended to have increased attacks on days with high oxidant and particulate pollution, on cool days, and during the first two months of the study. Panelists' attack propensity also differed by day of week; in particular they had more attacks on Saturdays (the last day of the weekly reporting period) than on Sundays. Each panelist's regression coefficients are classified according to his age, sex, hay fever status and self-assessed attack precursors; this classification is used to examine subgroups among the panelists with high coefficients corresponding to the above factors.

24777 (NTIS/PS—79/1060) **Nitrogen oxide air pollution, part 4. Biological effects (a bibliograhy with abstracts). Report for 1964-August 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Oct 1979. 189p. NTIS PC N01/MF N01.

The effects of nitrogen oxide air pollution on humans, plants, and animals are covered in the bibliography. Toxicology, epidemiology, pathology, and the synergistic effects of nitrogen oxides and other pollutants are covered. (This updated bibliography contains 182 abstracts, 25 of which are new entries to the previous edition.)

24778 Long-term effects of radium exposure in female dial workers: liver function and liver disease. Polednak, A.P. (Argonne National Lab., IL). *Environ. Res.;* **18**: No. 2, 454-465(Apr 1979).

The question of the long-term effects of α-emitting radionuclides on the liver is of considerable interest. Liver function test results and data on the prevalence of and mortality from diseases of the liver and biliary tract were examined among women who were first employed before 1930 in the US radium watch-dial painting industry, and who had a radium body-burden measurement while living (1958 to 1976). There was little evidence for a relationship between radium intake dose (initial systemic burden in μCi) and serum levels of albumin, total bilirubin, glutamic oxaloacetic transaminase (SGOT), or cholesterol in 142 long-term survivors, using both univariate and multivariate satistical analyses. Mean SGOT level was significantly higher in the highest intake dose ($\geq$ 50 μCi) than in the lower intake-dose groups, suggesting the need for continued clinical follow-up. Among 264 women with a serum alkaline phosphatase determination, a lack of significant association with intake-dose was noted. The prevalence of diagnosed diseases of the liver or biliary tract (i.e., cirrhosis, infectious hepatitis, and cholecystitis) was not significantly related to intake-dose level in 683 women, nor were the observed numbers of deaths from cirrhosis of the liver or liver cancer significantly increased relative to the US white female population. The findings were discussed in terms of estimated absorbed (rad)doses and in relation to the findings of studies on other radiation-exposed human populations.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

REFER ALSO TO CITATION(S) 23524, 24030

24779 Modification by cysteamine of ultrasound lethality to Chinese hamster V-79 cells. Fu, Y.K. (Univ. of Rochester, NY); Kaufman, G.E.; Miller, M.W.; Griffiths, T.D.; Lange, C.S. Contract EY-76-C-02-0069. *Radiat. Res.;* **80**: No. 3, 575-580(Dec 1979).

Exposure of Chinese hamster V-79 cells to 1.1-MHz continuous wave (C-W) ultrasound at intensities of 10, 20, and 30 W/cm^2 resulted in cell lysis and the loss of reproductive integrity (i.e., a decrease in plating efficiency) in the remaining intact cells. Sonication in the presence of 8 mM cysteamine, a free-radical scavenger, did not alter the amount of cell lysis, but did result in a smaller decrease in plating efficiency at 20 and 30 W/cm^2. Hence, while free radicals do not appear responsible for ultrasonically induced cell lysis, free radicals do appear to be at least partially responsible for loss of reproductive integrity in the remaining intact cells.

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 23518, 23697, 23730, 23732, 23735, 23737, 23739, 23741, 23742, 24660

24780 (DOE/DP/01253—18) **Thermodynanmic relations between selected parameters describing unsaturated flow.** Case, C.M. (Nevada Univ., Las Vegas (USA). Desert Research Inst.). May 1980. Contract AC08-76DP01253. 47p. NTIS, PC A03/MF A01.

The first law of thermodynamics is applied to unsaturated flow by replacing the usual PdV term (P is pressure and V is volume) for chemical system which appears there by psi d θ/sub s/ (phi is matric suction and θ/sub s/ is the degree of saturation). If the assumption is made that hysteretic behavior of the moisture characteristic can be ignored, all the usual thermodynamic relations can be derived in which P is replaced by phi and V is replaced by θ/sub s/ and the various thermodynamic potentials, internal energy, U, entropy S, and so on, are understood to be normalized to unit void volume of the soil being considered. This leads to a thermodynamically derived theoretical expression for the slope of the moisture characteristic in terms of θ/sub s/, temperature, T, and the thermal expansivity of water, β/sub l/. When hysteresis is considered, it is shown that for certain types of laboratory experiments the area enclosed by the main branches of the hysteresis loop in the phi - θ/sub s/ plane, or by extension any closed loop traversed by the system in the phi - θ/sub s/ plane, represents, to the extent that the sample temperature is kept constant during the adsorption-desorption process, the void volume of the sample multiplied by the integral of the temperature and the differential of the entropy generated by carrying out the cyclic adsorption-desorption process. These results when combined with an explicit representation of phi interms of an integral over the poor radius distribution allow an explicit calculation of the entropy change in terms of physical parameters.

24781 (PB—299924) **Site 32sn102, Stutsman County, North Dakota: a description and analysis. Final report August-December 1978.** Fox, R.A. J540; Pearson, J. (North Dakota Univ., Grand Forks (USA). Dept. of Anthropology and Archaeology). 15 Dec 1978. Contract DACW45-78-M-2871. 69p. NTIS, PC A04/MF A01.

Site 32N102 is situated on the east side of Pipestem Lake, a man-made reservoir in Stutsman County, North Dakota. The site appears to be a secondary burial containing the remains of four individuals. Bone fragments were radiocarbon dated at 1591 B. C. + or - 70. Because the site was being disturbed by lacustrine erosion, the Corps of Engineers, Omaha District contracted with University of North Dakota Archaeological Research, University of North Dakota for salvage investigation. Salvage operations were initiated in August of 1978. Laboratory analyses were conducted later in the fall. The osteological remains represent two females, a male, and an infant. The latter was aged from 2 to 6 years at the time of death. The male was approximately 40 to 50 years of age and the two females were 18 to 21 and 19 to 25 years old.

24782 (UCRL—52909) **LLL continental drilling for scientific purposes data base: DOE-funded drill holes.** Howard, N.W.; Qualheim, B.J.; Hage, G.; Higuera, M.L.; Pawloski, G.; Bell, C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Feb 1980. Contract W-7405-ENG-48. 456p. NTIS, PC A20/MF A01.

The investigation of such topics as deep continental basins and basement structures, as well as studies of the earth's crust in general, are dependent on data from deep holes. An information system was set up to collect data from existing and proposed deep drilling holes. This report contains such information about holes that have been drilled, or are planned for drilling, with funding from DOE. Parameters of the data base are described; information for DOE-funded holes forms the bulk of the report. Output of data now in the system is available on request. 3 figures, 2 tables.

GEOPHYSICS

SEISMOLOGY AND TECTONICS

REFER ALSO TO CITATION(S) 23745, 23746

24783 (PB—301144) **Microzonation for safer construction-research and application. Proceedings of International Conference (2nd), held at San Francisco, California on November 26-December 1, 1978. Volume I.** (Washington Univ., Seattle (USA)). Dec 1978. 516p. NTIS, PC A22/MF A01.

Two conference sessions are reported. The first covers geology, seismology, geophysics, and side effects. Seismic investigations of various regions in the world were presented together with earthquake prediction studies. Considerable attention was devoted to such theoretical aspects as peak horizontal and vertical accelerations, the relevancy of one dimensional shear models in predicting surface acceleration, and the theory of connectivity. The second session dealt with soil dynamics, soil structure interaction, and ground effects. Various aspects of liquefaction potential were presented. Stuides of shear deformationo in sandy soils byacoustic emission response and seismic shear strain induced in soil deposits were reported. Recent earthquake resistant design methods for different types of foundations in Japan were described. In general, each topic

was prefaced by an abstract and an introduction followed by the methodology, results, conclusions, and references.

24784 (UCRL—15220) **High frequency seismic signals at five United States observatories. Final report.** Racine, D.; Klouda, P.; Burnetti, J. (Teledyne Geotech, Alexandria, VA (USA)). Feb 1980. Contract W-7405-ENG-48. 47p. NTIS, PC A03/MF A01.

High-frequency (HF) data channels were operating at five VELA observatories - Blue Mountain Seismological Observatory (BMSO) near Baker, Oregon, Uinta Basin Seismological Observatory (UBSO) near Vernal, Utah, Tonto Forest Seismological Observatory (TFSO) near Payson, Arizona, Wichita Mountain Seismolozical Observatory (TFSO) near Payson, Arizona. Wichita Mountain Seismological Observatory (WMSO) near Layton, Oklahoma and Cumberland Plateau Seismological Observatory (CPSO) near McMinnville, Tennessee - between the months of October 1965 and July 1966. These HF channels had peak responses of from 6 to 10 Hz and were recorded along with normal short-period (SP) data channels, on 16 mm film and 14 channel analog magnetic tape. The purpose of this study is to investigate the propagation characteristics and detection thresholds of the HF energy content of earthquakes located within 20 degrees of these observatories. Also examined are three underground nuclear explosions - Rex, Piledriver and Longshot (teleseismic distance).

24785 (UCRL—15221) **Seismicity of the salt areas of Texas, Louisiana, Oklahoma and Kansas.** Racine, D.; Klouda, P. (Teledyne Geotech, Alexandria, VA (USA)). Feb 1980. Contract W-7405-ENG-26. 29p. Dep. NTIS, PC A02/MF A01.

The results of a seismicity study of the salt deposit areas of Kansas, Oklahoma, Texas and Louisiana are presented. The study was conducted using some of the short-period seismic data recorded on film at the Wichita Mountain Observatory (WMSO), located in southern Oklahoma, during the years 1961 through 1968. Only data recorded on Sundays were analyzed to minimize the confusion of quarry blasts. All major quarries within 400 km of WMSO were located and some of the known blasts were studied for distinguishing characteristics. Inquiries were made to the appropriate state agencies for data to produce a list of historical seismic events which occurred during the 1961 to 1968 period. A salt deposit composite map of the areas was also produced and all historical and previously unreported events, as well as the known quarries, were plotted on this base map.

24786 **New evidence for tectonic uplift in the Diablo Plateau region, West Texas.** Reilinger, R.; Brown, L.; Powers, D. (Department of Geological Sciences, Cornell University, Ithaca, New York 14853). *Geophys. Res. Lett.;* 7: No. 3, 181-184(Mar 1980).

Recent releveling measurements conducted by the National Geodetic Survey in West Texas and southeastern New Mexico indicate uplift of the Diablo Plateau-Salt Basin region relative to benchmarks to the northeast in the Great Plains. These new measurements confirm and enhance the previously reported interpretation of releveling data in this area. Total relative uplift measured between 1934 and 1977 reaches 19 +- 3 cm. Combining this new information with leveling data from 1934, 1943 and 1958 along this same route indicates that: (1) the uplifted area extends 120 km in the east-west direction (there is presently no control on any north-south component of tilting), with maximum relative uplift occurring approcimately 12 km west of the boundary between the Diablo Plateau and Salt Basin graben; and (2) on the time scale between measurements (~20 yrs), uplift appears to be occurring more or less continuously, although not at a constant rate. The progressive deformation indicated by the releveling measurements, the large magnitude relative to possible leveling errors, and the spatial dimensions of the uplift rule out systematic errors or near-surface effects (water table variations, sediment compaction, etc.) as an explanation and favor a tectonic origin. Intrucrustal magnetic activity or some form of preseismic deformation (dilatancy, fault creep at depth, etc.) appear to be the most reasonable explanations in view of presently available geologic and goephysical information.

GEOPHYSICAL SURVEY METHODS

24787 **Cross-borehole electromagnetic probing to locate high-contrast anomalies.** Lytle, R.J.; Laine, E.F.; Lager, D.L.; Davis, D.T. (Univ. of California, Livermore). *Geophysics;* **44**: No. 10, 1667-1676(Oct 1979).

Electromagnetic (EM) probing between boreholes is useful for locating high-contrast geophysical anomalies such as a tunnel. Theoretical and experimental studies of EM field interaction with a tunnel show that minima in the received signal can be used for locating the tunnel. The theoretical studies show that, as a transimitter and receiver are lowered in separate boreholes, the minima can be interpreted easily to yield both the lateral and vertical positions of the tunnel. The main mechanism of EM field interaction with the tunnel appears to be diffraction, and the spatial variation of the feld strength is affected by the tunnel shape. Frequencies from 10 to 70 MHz were studied to assess the usable frequencies. The field in the receiver borehole was an effective diagnostic when a half-wavelength in the surrounding medium was less than or equal to the diameter of the tunnel. EM probing at two test sites gave the locations of tunnels within 1 ft of the surveyed locations. 20 figures.

24788 **Magnetotellurics with a remote magnetic reference.** Gamble, T.D.; Goubau, W.M.; Clarke, J. (Univ. of California, Berkeley). *Geophysics;* **44**: No. 1, 53-68(Jan 1979).

Magnetotelluric measurements were performed simultaneously at two sites 4.8 km apart near Hollister, California. SQUID magnetometers were used to measure fluctuations in two orthogonal horizontal components of the magnetic field. The data obtained at each site were analyzed by using the magnetic fields at the other site as a remote reference. In this technique, one multiplies the equations relating the Fourier components of the electric and magnetic fields by a component of magnetic field from the remote reference. By averaging the various crossproducts, estimates of the impedance tensor not biased by noise are obtained, provided there are no correlations between the noises in the remote channels and noises in the local channels. For some data conventional methods of analysis yielded estimates of apparent restrictivities that were biased by noise by as much conventional methods of analysis yielded estimates of apparent resistivity obtained from these same data, with the remote reference technique, were consistent with apparent resistivities calculated from relatively noise-free data at adjacent periods. The estimated standard deviation for periods shorter than 3 s was less than 5%, and for 87% of the data, was less than 2%. Where data bands overlapped between periods of 0.33 s and 1 s, the average discrepancy between the apparent resistivities was 1.8%. 16 figures, 5 tables.

24789 **Magnetotelluric soundings of crustal conductive zones in major continental rifts.** Jiracek, G.R.; Ander, M.E.; Holcombe, H.T. (Univ. of New Mexico, Albuquerque). pp 209-222 of Rio Grande Rift: tectonics and magmatism. Riecker, R.E. (ed.). Washington, DC; American Geophysics Union (1979).

Following the successful seismic soundings across the Rio Grande rift in New Mexico by the Consortium for Continental Reflection Profiling (COCORP), eight magnetotelluric stations were occupied in the area in 1977. The MT stations were positioned so as to traverse a strong reflection seismic event which correlated with a magma chamber previously interpreted at about 20 km depth using microearthquake observations. Results from these MT stations within and transitional to the Rio Grande rift are compared to similar soundings from the Baikal rift in eastern Siberia, the East African rift, and the Rhine graben in Germany. All interpretations made within the rifts themselves have a common characteristic that a zone of low resistivity (≦ 50 ohm-m) is modeled at depths less than 30 km. This conductive layer is not observed in the crust in adjacent regions. Laboratory measurements support the view that such a zone can result when significant amounts of pore fluids are present in an enhanced geothermal gradient giving rise to partial melting in the crystalline basement.

24790 **Magnetotelluric data analysis: removal of bias.** Goubau, W.M.; Gamble, T.D.; Clarke, J. (Univ. of California, Berkeley). *Geophysics;* **43**: No. 6, 1157-1166(Oct 1978).

Two new techniques for analyzing 4-channel magnetotelluric (MT) data are described. These techniques produce estimates of the elements, Z/sub ij/, of the impedance tensor that are unbiased by noise in the autopowers of the electric and magnetic fields. Effectively, each technique uses one field channel as a reference signal that can be correlated with the other three channels. Method 1 obtains estimates for the Z/sub ij/ in terms of crosspowers of the Fourier components of the electric and magnetic fields E/sub x/(ω), E/sub y/(ω), H/sub x/(ω), and H/sub y/(ω). Method 2 is a generalization of method 1, and obtains estimates for Z/sub ij/ in terms of weighted crosspowers. Both methods fail when the geology is one-dimensional, or two-dimensional with one electrode oriented along the strike direction. To obtain results that are stable for any geology and that are unbiased by autopower noise, at least five channels of data are required. To also minimize bias by correlated noises, one needs six channels of data, two channels of which are for fields measured at a site that is remote from the base MT station. The analysis of MT data using a remote magnetometer as a reference is discussed. 2 figures. 3 tables.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 23731, 24783

24791 (UCRL—15234) **Effect of principal stress magnitudes on hydrofracturing orientation.** Haimson, B.C. (Wisconsin Univ., Madison (USA). Dept. of Metallurgical and Mineral Engineering). Dec 1979. Contract W-7405-ENG-48. 7p. Dep. NTIS, PC A02/MF A01.

The emphasis during the reported period of the project was on the effect of borehole fluid viscosity on hydrofracturing results. To carry out these tests we used different hydraulic oils of known viscosities under a preset state of stress. Two conditions were investigated: one in which the largest horizontal compressive stress (σ/sub H/) was only slightly larger than the least horizontal stress (σ/sub h/), and both were considerably smaller than the vertical stress (σ/sub V/), and another in which σ/sub V/ was substantially less than either σ/sub H/ or σ/sub h/.

24792 Criteria for impulsive rock fracture. Grady, D.E.; Lipkin, J. (sandia Laboratories, Albuquerque, New Mexico 87185). *Geophys. Res. Lett.;* 7: No. 4, 255-258(Apr 1980).

Explosive or percussive breakage of rock relies on impulsive rock fracture and both the fracture stress and fracture energy under such conditions are observed to be significantly greater than measured quasi-statically. The implication of rate dependence has been verified in recent tensile fracture studies and in the present reprot this data has been compiled, significant trends noted, and comparisons made with earlier impulsive fracture criteria.

24793 Shock wave studies in Blair dolomite. Larson, D.B. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Geophys. Res.;* **85**: No. B1, 293-298(10 Jan 1980).

Two types of shock wave experiments have been conducted on samples of Blair dolomite. The first employed a light-gas gun to produce uniaxial strain, while the second used a spherical high-explosive charge to cause radial deivergent flow. Comparisons of data taken from these two types of experiments (at strain rates of 10^6/s and 10^4/s, respectively) with quasi-static data (at 10^{-4}/s) show that Blair dolomite is strongly time dependent in its behavior. This time dependence appears over the entire stress interval from 0.24 to 5.33 GPa.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 23748

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

STARS

24794 Formation of solar-type stars in spherical symmetry. I. The key role of the accretion shock. Winkler, K.A.; Newman, M.J. (Theoretical Division, Los Alamos Scientific Laboratory, University of California; and Max-Planck-Institut fuer Physik und Astrophysik, Munich, F.R.G.). *Astrophys. J.;* **236**: No. 1, 201-211(15 Feb 1980).

Time-dependent hydrodynamical calculations of the self-gravitational collapse of a homogeneous Jeans unstable 1 M/sub sun/ protostellar cloud are examined to determine the extent to which the physical results reported in the literature depend on the particular numerical methods employed. It is found that the use of large artificial viscosity in the numerical treatment of shock fronts over-estimates the heating of the gas, underestimating the rate of production of radiation. Damping of core oscillations by increasing the inertial mass in contraction phases artificially slows the contraction, therefore overestimating the core radius. Large discretization errors lead to difficulties with numerical energy conservation, resulting in overlarge values for radius and total luminosity. A calculation employing a numerical method seeking to avoid these difficulties is presented. When numerical uncertainties are taken into account, the most likely physical solution produces a radius for the final core of about 2 R/sub sun/ and a total luminosity of order 1 L/sub sun/ when all the mass is assembled in the core. The maximum luminosity during the accretion phase is approximately 30 L/sub sun/. In the shock front surrounding the stellar core almost all the kinetic energy gained from the gravitational acceleration is directly transformed into outgoing radiation and is not deposited in the internal energy of the gas, in good agreement with the assumptions of the early work of Larson. The structure of the second shock front during the main accretion phase is examined in detail, and the evolution in the Hertzsprung-Russell diagram is discussed.

24795 Theoretical period ratios for RR Lyrae variables and AQ Leonis. Cox, A.N.; King, D.S.; Hodson, S.W. (Theoretical Division, Los Alamos Scientific Laboratory, University of California). *Astrophys. J.;* **236**: No. 1, 219-224(15 Feb 1980).

The ratio of the overtone to fundamental periods has been calculated for models of RR Lyrae variables by using the linear nonadiabatic theory. Both homogeneous envelope and helium-enriched surface-layer models have been considered in order to predict the observed period ratio for the only known Population II double-mode RR Lyrae variable AQ Leonis. It is shown that the period ratio for homogeneous models in the radial pulsation instability strip depends only on the fundamental mode period at 0.58 M/sub sun/ and 0.65 M/sub sun/ and does not depend on the luminosity or surface effective temperature. The AQ Leo period of 0/sup d/.55 and the period ratio of 0.746 can be explained with a homogeneous composition model with a mass of 0.65 M/sub sun/. No surface helium enrichment is necessary for this variable even though such enrichment seems to be necessary for the more luminous double- and triple-mode Cepheids. It appears that the double-mode behavior of AQ Leo can be explained by mode switching in its blueward or redward horizontal branch evolution. This mode switching is rapid compared with its lifetime as an RR Lyrae variable.

SOLAR PHENOMENA

24796 (LA—8344-T) Solar wind flows associated with hot heavy ions. Fenimore, E.E. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 58p. NTIS, PC A04/MF A01. Thesis.

Solar wind heavy ion spectra measured with the Vela instrumentation have been studied with the goal of determining the solar origins of various solar wind structures which contain anomalously high ionization states. Since the ionization states freeze-in close to the sun they are good indicators of the plasma conditions in the low and intermediate corona. Heavy ion spectra from three different periods throughout the solar cycle have been analyzed. These data are consistent with freezing-in temperatures ranging from $\sim 1.5 \times 10^6$ K to higher than 9×10^6. The spectra indicating hot coronal conditions occur in roughly 1/7 of all measurements and almost exclusively in postshock flows (PSFs), nonshock related helium abundance enhancements (HAEs), or noncompressive density enhancements (NCDEs). The PSFs and HAEs are both probably interplanetary manifestations of solar flares. The observation of several flare-related HAEs which were not preceded by an interplanetary shock suggests that the flare-heated plasma can evolve into the solar wind without producing a noticeable shock at 1 AU. The NCDEs with hot heavy ions differ from the PSF-HAEs in several ways implying that they evolve from events or places with lower temperatures and less energy than those associated with the flares, but with higher temperatures and densities than the quiet corona. Active regions, coronal mass ejections, and equatorial streamers are possible sources for the NCDEs with spectra indicating hot coronal conditions. These events owe their enhanced densities to coronal processes as opposed to interplanetary dynamical processes. Models of the solar wind expansion demonstrate how some NCDEs can have extreme, nonequilibrium ionization distributions.

24797 Impulsive 2—10 keV solar electron events not associated with flares. Potter, D.W.; Lin, R.P.; Anderson, K.A. (Space Sciences Laboratory, University of California). *Astrophys. J., Lett. Ed.;* **236**: No. 2, L97-L100(1 Mar 1980).

Data from the ISEE3 satellite reveal a class of impulsive solar electron events with no measurable increase in flux above 10—20 keV. The flux histories and angular distributions indicate that the electrons propagate through interplanetary space with little or no scattering. The smooth extension of the power-law energy spectra down to the limit of the observations at 2 keV indicates that the electrons are accelerated at altitudes greater than 0.5 R/sub sun/ in the solar corona. Although these events occur more frequently than any other type of impulsive solar particle event observed, we have found no correlation with flares or flare-related activity. However, there is a close correlation with low-frequency (<1 MHz) type III radio bursts.

24798 Solar wind ions accelerated to 40 keV by shock wave disturbances. Gosling, J.T.; Asbridge, J.R.; Bame, S.J.; Feldman, W.C.; Paschmann, G.; Sckopke, N. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Geophys. Res.;* **85**: No. A2, 744-752(1 Feb 1980).

Observations in the solar wind with the LASL/MPI fast plasma experiment on ISEE 1 and 2 reveal the common presence of ions with energies extending from ~100 eV up to at least 40 keV in a broad region, typically $\sim 10^7$ km wide, following interplanetary shocks. Peak differential fluxes up to $\sim 5 \times 10^3$ (cm^2 s sr keV)$^{-1}$ at 28 keV are observed either at the shock or within the first ~1.5 hours following shock passage. In the solar wind frame the distribution function $f(v)$ of these ions is roughly isotropic, peaks near zero velocity, and above ~5 keV can adequately be characterized as power law in energy with a spectral index of ~2.7. The effective 'temperature' of these ions generally exceeds 10^8 °K. These suprathermal interplanetary ions are almost certainly solar wind ions which have been accelerated by some mechanism associated with the shock wave disturbance. Present evidence leads the authors to favor stochastic particle acceleration involving electrostatic and/or electromagnetic turbulence in the postshock flow.

COSMOLOGY

24799 Horizon problem and the broken-symmetric theory of gravity. Zee, A. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104). EY-76-C-02-3071. *Phys. Rev. Lett.;* **44**: No. 11, 703-706(17 Mar 1980).

A way of avoiding the standard scenario (which many people find vexing on philosophical grounds) is suggested in which particles are in causal contact with only a limited number of other particles in the early universe.

24800 Phase transitions and magnetic monopole production in the very early universe. Guth, A.H.; Tye, S.H. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-AC03-76SF00515. *Phys. Rev. Lett.;* **44**: No. 10, 631-635(10 Mar 1980).

In grand unified models, the abundance of superheavy magnetic monopoles in the universe can be suppressed if (1) the phase transition which creates the monopoles occurs after much supercooling; and (2) immediately after the phase transition, the effective monopole mass is large compared with the temperature. These requirements impose constraints on the history of the early universe. The Georgi-Glashow SU(5) group probably breaks to SU(4) x U(1) before it reaches SU(3) x SU(2) x U(1).

PLANETARY PHENOMENA

24801 (LA-UR—80-1199) Silver isotopic anomalies in iron meteorites: cosmic-ray production and other possible sources. Reedy, R.C. (Los Alamos Scientific Lab., NM (USA)). 18 Apr 1980. Contract W-7405-ENG-36. 18p. (CONF-800361—1). NTIS, PC A02/MF A01.

From 11. lunar and planetary science conference; Houston, TX, USA (Mar 1980).

The sources of excess ^{107}Ag observed in iron meteorites by Kaiser, Kelly, and Wasserburg (1980) are examined, with emphasis on the reactions of cosmic-ray particles with palladium. The cross sections for the production of the silver isotopes from palladium by energetic cosmic-ray particles are evaluated or estimated and used to calculate spallogenic production rates relative to that of ^{53}Mn from iron. The upper limit for the production rate of excess ^{107}Ag by galactic-cosmic-ray particles is 400 atoms/min/kg(Pd) which, over an exposure age of 10^9 years, would make only 1% of the observed excesses of ^{107}Ag. Neutron-capture reactions with Pd isotopes produce mainly ^{109}Ag. Binary fission of a siderophilic superheavy element would be expected to yield more ^{109}Ag than ^{107}Ag. An intense proton irradiation in the early solar system probably would produce a lower ratio of ($^{107}Pd/^{108}Pd$) to ($^{26}Al/^{27}Al$) than observed in meteorites. Therefore the presence of excess ^{107}Ag in iron meteorites with large Pd/Ag ratios very likely is due to the incorporation of 6.5 x 10^6-year ^{107}Pd of nucleosynthetic origin in these meteorites.

ATMOSPHERIC PHYSICS

AURORAL AND IONOSPHERIC PHENOMENA

24802 Prompt striations in ionospheric barium clouds due to a velocity space instability. Simons, D.J.; Pongratz, M.B.; Peter Gary, S. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Geophys. Res.;* **85**: No. A2, 671-677(1 Feb 1980).

The linear theory of electrostatic instabilities of the drift loss-cone type has been developed for a velocity distribution appropriate to the shaped-charge barium injection experiment Buaro. The dispersion relation for the instability in a Vlasov plasma has been solved numerically. The results show a low-frequency instability that we interpret as the source of prompt striations observed in Buaro and cyclotron instabilities that appear to correspond to observed ion cyclotron fluctuations. These instabilities have much faster growth rates than drift instabilities of fluid theories and therefore provide a better description of the observations.

MAGNETOSPHERIC PHENOMENA

24803 Average parallel electric field deduced from the latitude and altitude variations of the perpendicular electric field below 8000 kilometers. Mozer, F.S.; Torbert, R.B. (Space Sciences Laboratory, University of California, Berkeley, California 94720). *Geophys. Res. Lett.;* **7**: No. 3, 219-221(Mar 1980).

The average equatorward component of the perpendicular electric field between the dusk plasmapause and polar cap has been determined at seven altitudes below 8000 kilometers by averaging large scale electric field measurements made on 166 passes of the S3-3 satellite through the dusk auroral zone. The observed variation of the perpendicular electric field with altitude and latitude requires the presence of an upward pointing parallel electric field over a latitude range of a few degrees centered near 70° invariant latitude, and with a maximum parallel potential of several kilovolts.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

24804 (DOE/ER/10460—1) Symposium on atomic spectroscopy. (National Academy of Sciences, Washington, DC (USA)). 1979. Contract AC02-79ER10460. 282p. (CONF-790997—). Dep. NTIS, PC A13/MF A01.

From SAS-79 symposium on atomic spectroscopy; Tuscon, AZ, USA (10 Sep 1979).

Topics covered by the conference include: fast beam spectroscopy; astrophysical and other spectra; highly ionized spectroscopy; complex spectra; rydberg levels; fine structure, hyperfine structure and isotope shift; lineshapes; lifetimes, oscillator strengths and Einstein coefficients; and spectroscopy with lasers. Abstracts of the conference papers are presented. (GHT)

BEAMS AND THEIR REACTIONS

24805 (DOE/ER/06036—3) X-ray emission in heavy-ion collisions. Progress report, April 1, 1979-March 31, 1980. Watson, R.L. (Texas A and M Univ., College Station (USA). Dept. of Chemistry). Apr 1980. Contract AS05-78ER06036. 51p. Dep. NTIS, PC A04/MF A01.

Recent research in the cyclotron institute and department of chemistry at Texas A and M University on the x-ray emission in heavy-ion collisions is described. Areas covered include: spectra of Ka x-rays from 64 MeV sulfur ions traveling in solids; foil-excited Ka x-ray transitions in few-electron sulfur ions; high-resolution study of the target thickness dependence of x-ray emission from 65 MeV sulfur ions; dynamic screening of highly stripped sulfur ions in solids; Mg Ka x-ray satellites excited by ion bombardment, multiplet structure and dependence on projectile and chemical environment; angular distributions of beam and target Ka x-rays; chemical effects on K x-ray satellites of fluorine compounds; and a non-linear least-squares peak-fitting program employing Voight functions. (GHT)

24806 Auger spectra induced by 100-keV Ar^+ impact on Be, Al, and Si. Metz, W.A.; Legg, K.O.; Thomas, E.W. (School of Physics, Georgia Tech, Atlanta, Georgia 30332). *J. Appl. Phys.;* **51**: No. 5, 2888-2893(May 1980).

The Auger electron spectrum induced by the impact of 100-keV Ar^+ on metallic aluminum is shown to be consistent with the source of Auger electrons being ejected target particles. The principal spectral line has been identified as being due to ejected Al atoms with a single 2p vacancy. Subsidiary peaks are due to ejected atoms and Al^+ ions with one or two 2p vacancies. The ion-induced Auger spectrum of silicon is similar. By contrast the spectrum induced by Ar^+ impact on Be exhibits a rather broad peak characteristic of a K-shell vacancy and is similar to that induced by the impact of electrons. By considering the lifetime of the Be K-shell vacancy we conclude that the Auger decay occurs while the Be atoms are either in the solid or interacting with the surface.

24807 Azimuthal anisotropies of dimer ions ejected from ion bombarded Ni(001). Holland, S.P.; Garrison, B.J.; Winograd, N. (Department of Chemistry, The Pennsylvania State University, University Park, Pennsylvania 16802). W-7504-ENG-48. *Phys. Rev. Lett.;* **44**: No. 11, 756-759(17 Mar 1980).

The angular distributions of Ni^+ and Ni_2^+ ejected from Ni(001) by bombardment with 2-keV Ar^+ have been shown to exhibit large azimuthal anisotropies. The experimental results have been well reproduced by classical dynamical calculations of the ion impact event. For the dimers, the peak in the distribution arises from a unique ejection mechanism such that the atoms in the dimer are known to form from specific surface locations relative to the ion impact position.

24808 Retention and re-emission of 0.125— 1-keV deuterium in stainless steel. Thomas, E. (UKAEA, Culham Laboratory, Abingdon Oxon, OX14 3DB, United Kingdom, UK (Euratom)/UKAEA Fusion Association). *J. Appl. Phys.;* **51**: No. 2, 1176-1183(Feb 1980).

Retention and re-emission of 125— 1000—eV D^+ ions in stainless steel has been measured at 90, 300, and 500 °K. Saturation of retained fluence in a 90 °K target occurs when there is approximately one retained atom for every metal atom within the range of this projectile. Implantation at 300 and 500 °K shows saturation at densities three to five times smaller than the low-temperature implant. Backscattering coefficients are determined to range from 0.5 at 125 eV to 0.3 at 1 keV; these are consistent with computer simulations. Thermally induced re-emission of deuterium retained after bombarding a room temperature target has a diffusive character with an activation energy of 14.7 kcal/mole.

24809 Radio frequency magnetron sputtering of thick film amorphous beryllium. Burt, R.J.; Meyer, S.F.; Hsieh, E.J. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). W-7405-ENG-48. *J. Vac. Sci. Technol.;* **17**: No. 1, 407-410(Jan 1980).

Thick film coatings of beryllium, needed for the low-Z ablator layer in proposed laser fusion targets, have been prepared using high rate magnetron rf sputtering. The requirements for these Be coatings include thicknesses from 5 to 50 μm, complete freedom from surface defects, and an average surface roughness of 100 nm or less. These specifications are difficult to achieve if crystalline growth occurs during sputtering, since the surface roughness of thick grainy films can be on the order of micrometers. We have sputtered very smooth, dense Be films up to 25 μm thick with surface roughness less than 100 nm. X-ray diffraction analysis of impurity doped films indicates an amorphous-like structure. Impurity stabilized amorphous Be with smooth surfaces is reported on both 15°C cooled copper and nominal 200°C glass substrates. The sputtering parameters (substrate temperature, deposition rate, argon pressure, and impurity gas levels) affecting surface roughness and film structure are discussed in terms of SEM, AES, and x-ray diffraction results.

24810 Measurement of the n = 2 density operator for hydrogen atoms produced by passing protons through thin carbon targets. Gabrielse, G.; Berry, H.G. (Chicago Univ., IL (USA). Dept. of Physics; Argonne National Lab., IL (USA)). *J. Phys. (Paris), Colloq.;* No. 1, C1.338-C1.339(1979).

From 5. International conference on beam-foil spectroscopy; Lyon, France (5 - 8 Sep 1978).

Measurements of the n = 2 density operators and the probability for n = 2 production, for hydrogen atoms produced by passing 20 to 1000 keV protons through thin carbon targets are reported.

24811 Temperature dependence of the beam-foil interaction. Gay, T.J.; Berry, H.G. (Chicago Univ., IL (USA). Dept. of Physics; Argonne National Lab., IL (USA)). *J. Phys. (Paris), Colloq.;* No. 1, C1.298-C1.300(1979).

From 5. International conference on beam-foil spectroscopy; Lyon, France (5 - 8 Sep 1978).

The beam energy dependence between 50 and 200 keV of the linear polarization fraction (M/I) of the 2s ^{1}S - 3p ^{1}p, 5016 A transition in He I on temperature has been measured. The thin carbon exciter foils were heated externally by nichrome resistance elements. The energy and current dependences are the same assuming corresponding between beam heating and external heating. It is observed that γ, the number of slow secondary electrons produced per incident ion decreases, with increasing foil temperature. These two effects, in conjunction, offer a plausible explanation for the variation of polarization with beam current density.

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 24818, 24829

24812 Vibrational relaxation in jet-cooled alkyl benzenes. II. Fluorescence spectra. Hopkins, J.B.; Powers, D.E.; Mukamel, S.; Smalley, R.E. (Rice Quantum Institute). *J. Chem. Phys.;* 72: No. 9, 5049-5061(1 May 1980).

Dispersed fluorescence spectra of a series of laser-excited n-alkylbenzenes cooled in a supersonic free jet have been obtained under effectively collision-free conditions. The series includes all members of the n-alkylbenzene family from methyl- through n-hexylbenzene. Pulsed laser excitation was cleanly made into the 0^0_0, $6b^1_0$, 12^1_0, and $18a^1_0$ vibronic bands of the $^1B_2(\pi\pi^*)^1A_1$ ultraviolet absorption spectrum. Resonance fluorescence from the O^0_0 excitation experiments permitted clear assignment of the six ring modes (6a, 6b, 1, 12, 18a, 9a) which in combinations and short progressions dominate the fluorescence spectra of these molecules. Except for 6a and 1, the frequency of these ground state vibrations is found to be constant throughout the alkylbenzene series to better than 1 part in 100. Fluorescence from the $6b^1_0$, 12^1_0, and $18a^1_0$ excitation experiments with alkylbenzenes of successively longer chains showed clearly the onset and increasing importance of intramolecular vibrational relaxation (IVR) occurring in the $^1B_2(\pi\pi^*)$ state prior to emission. By comparing the relative intensity of the resonance and relaxed fluorescence, a lower limit to the rate of the IVR process has been measured as a function of the type of system mode excited ($6b^1$, 12^1, or $18a^1$) and as a function of the size and nature of the bath (the alkyl chain in its various conformations). As expected this IVR rate increases with increasing alkyl chain length. For $6b^1_0$ excitation (vibrational energy, E/sub v/=530 cm^{-1}) the IVR process is first observable in n-(t)-butylbenzene where the IVR rate, k/sub vr/, is > or =5 x 10^6 sec^{-1}. This rate increases to > or =4 x 10^7 sec^{-1} and >10^9 sec^{-1} in $6b^1_0$ excited n-(t)-pentyl- and n-(t)-hexylbenzene, respectively. For 12^1_0 excitation (E/sub v/=933 cm^{-1}) k/sub vr/> or =10^8 sec^{-1} for n-(t)-propylbenzene and k/sub vr/ x 10^9 sec^{-1} for all higher n-(t)-alkylbenzenes.

24813 Saturation spectroscopy with laser optical pumping in atomic barium. Pappas, P.G.; Burns, M.M.; Hinshelwood, D.D.; Feld, M.S.; Murnick, D.E. (Department of Physics and Spectroscopy Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). ER-78-S-02-4629. *Phys. Rev., A;* 21: No. 6, 1955-1968(Jun 1980).

The magnitude and sign of laser saturation resonances induced in atomic transitions with level degeneracy can be dramatically altered by the presence of optical pumping. This paper presents a detailed theoretical treatment of optical-pumping Lamb dips and crossover resonances, and their experimental observation in the 553-nm barium resonance transition. The physical principles underlying the laser optical-pumping saturation effect are also discussed.

24814 Calculated spectroscopic constants for the X $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$, ^{3}Pi, and ^{1}Pi states of CCO. The heat of formation of CCO. Walch, S.P. (Theoretical Chemistry Group, Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *J. Chem. Phys.;* 72: No. 10, 5679-5686(15 May 1980).

Geometries, excitation energies, and vibrational frequencies have been calculated for the X $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$, ^{3}Pi and ^{1}Pi states of CCO using POL—CI wave functions based on GVB wave functions with a polarized valence double zeta basis set. The results are compared to known spectroscopic constants for the X $^3\Sigma^-$ and ^{3}Pi states of CCO. The calculated T/sub e/'s (experimental values in parenthesis) are 0.95 eV for $^1\Delta$, 1.58 eV for $^1\Sigma^+$, 1.49 eV (1.44) for ^{3}Pi and 3.49 eV for ^{1}Pi. The calculated vibrational frequencies are ν_1=1838 cm^{-1} (1978), ν_2=367 cm^{-1} (379.4), ν_3=1086 cm^{-1} (1074) for X $^3\Sigma^-$ and ν_1=1841 cm^{-1} (2045.7), ν_2=580 cm^{-1} (607.8), ν_3=1097 cm^{-1} (~1270) for ^{3}Pi. The D/sub o/ (C—CO) is calculated to be 30.6 kcal/mole with an estimated error of ~23 kcal/mole (based on comparable calculations for ketene) leading to an estimated D/sub o/ (C—CO) of 54 kcal/mole and a ΔH^0/sub f/o of 89 kcal/mole.

24815 L/sub 2,3/-subshell x-ray fluorescence and Coster-Kronig yields at Z=64 and 67. Gnade, B.E.; Braga, R.A.; Fink, R.W. (School of Chemistry, Georgia Institute of Technology, Atlanta, Georgia 30332). DE-AS05-76ERO-3346. *Phys. Rev., C;* 21: No. 5, 2025-2032(May 1980).

The total Coster-Kronig transition probability f_{23} for the L_2-L_3 transition and the L_2 and L_3 subshell x-ray fluorescence yields ω_2 and ω_3 were measured utilizing resolved L-K x-ray coincidence techniques for Z=64 and 67 with radioactive sources of 4.68-yr ^{155}Eu and 10.4-h ^{165}Er, respectively. Improved accuracy in the results is achieved by advances in the experimental method. The values of f_{23} are 0.130 +- 0.012 and 0.115 +- 0.011 at Z=64 and 67, respectively, and of ω_2 and ω_3 are 0.165 +- 0.022 and 0.161 +- 0.019 at Z=64, and 0.186 +- 0.023 and 0.180 +- 0.020 at Z=67, respectively. The quoted uncertainties are twice the average deviation from the mean of 12 values of f_{23} and two values each of ω_2 and ω_3, and arise predominantly from systematic errors.

24816 Titanium oxide Phi system. Galehouse, D.C.; Brault, J.W.; Davis, S.P. (Physics Department, University of California, Berkeley). *Astrophys. J., Suppl. Ser.;* 42: No. 2, 241-259(Feb 1980).

The Phi system (b ^{1}Pi—d $^1\Sigma$) of titanium oxide has been studied in emission in the near-infrared, with the Fourier transform spectrometer at Kitt Peak National Observatory, at a resolution of 800,000. Approximately 3000 lines from 25 bands of this system have been identified, including all five 0—0 and 0—1 bands corresponding to the five natural titanium isotopes. Six lower and five upper vibrational levels have been observed, and all bands have been rotationally analyzed. The molecular constants have been calculated. Band intensities are in reasonable agreement with known isotopic abundances and calculated Franck-Condon factors.

24817 Effect of satellite Q-branches on temperatures computed from oxygen vibrational Raman intensities. Hill, R.A. (Sandia Labs., Albuquerque, NM). *J. Quant. Spectrosc. Radiat. Transfer;* 21: 221-226(1979).

Splitting of the $^3\Sigma$/sub b/$^-$ ground states of molecular oxygen has a small but noticeable effect on the intensity distribution in the fundamental and hotband Raman Q-branches. An analysis of oxygen Q-branch spectra [computed for Hund's coupling case (b) and pure anisotropic scattering], with expressions corresponding to $^1\Sigma$ theory, results in temperature errors of -2.0% to -0.5% in the range 500 to 2000°K. 2 figures, 2 tables.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

REFER ALSO TO CITATION(S) 24937

24818 X-ray yields in protonium and mesic hydrogen. Borie, E.; Leon, M. (Institut fuer Theoretische Kernphysik der Universitaet Karlsruhe, 7500 Karlsruhe, West Germany). *Phys. Rev., A;* 21: No. 5, 1460-1468(May 1980).

Recent experimental investigations of atomic x rays in protonium have revived interest in the atomic cascade process. Following a calculation of Leon and Bethe, which includes chemical and Auger deexcitation, Stark mixing and annihilation, as well as radiative

transitions, we investigate the dependence of the yields of K and L x rays on the target density, and on the hadronic shifts and widths of the 1s and 2p levels. Numerical results are also given for kaonic, pionic, and muonic hydrogen.

COLLISION PHENOMENA

24819 (DOE/ER/10512—T1) **Differential charge transfer to the continuum by ions in atomic hydrogen. Progress report and renewal proposal.** Sellin, I.; Thoe, R.S. (Tennessee Univ., Knoxville (USA). Dept. of Physics and Astronomy). 1980. Contract AS05-79ER10512. 26p. NTIS, PC A03/MF A01.

It has been found, in measurements of fully stripped ions on rare gas targets, that current theories of electron capture to continuum states in hydrogenic approximation give a different projectile Z dependence from that observed experimentally. It is therefore proposed to study the projectile Z, velocity, angular, and charge state dependence of charge exchange to continuum states for H^+, C^{6+}, and O^{6+} ions on atomic hydrogen. The previously obtained results are discussed by way of background. Some technical details concerning work done in connection with the proposed experiment are given. An exploratory spectrum of continuum capture electrons from 234-MeV Ar^{18+} on H_2 is shown. 7 figures. (RWR)

24820 (ORO—3027-52) **Absolute experimental cross sections for the electron impact ionization of rubidium. Technical summary report.** Hughes, D.W.; Feeney, R.K. (Georgia Inst. of Tech., Atlanta (USA). School of Electrical Engineering). 31 Mar 1980. Contract EY-76-S-05-3027. 133p. Dep. NTIS, PC A07/MF A01.

The absolute cross sections for the double, triple, and quadruple ionization of Rb^+ ions by electron impact have been measured from below their respective thresholds to approximately 3000 eV. This determination has been accomplished using a crossed beam facility in which monoenergetic beams of ions and electrons are caused to intersect at right angles in a well-defined collision volume. Multiply charged, product ions born as a result of the electron impact are deflected into their respective detectors by cascaded electrostatic analyzers. The multiply charged beam current component is measured by means of a vibrating reed electrometer operating in the rate-of-charge mode. The required singly charged rubidium ions are produced in a thermionic ion source and pass through a series of focusing, collimating and deflecting structures before entering the interaction region. A thermionically generated, rectangular electron beam intercepts the target ions in a spatially designated collision volume. Just prior to entering this interaction region the two beams can be made to pass through a movable slit scanner which determines their spatial profiles. The various charged particle currents, energies and beam current density distributions represent the experimental data from which the desired absolute cross sections have been determined. The results obtained with this technique are compared with available theoretical predictions of the appropriate cross sections.

24821 **Integrals of the squared atomic form factor over the momentum transfer.** Matsuzawa, M.; Mitsuoka, S. (University of Electro-Communications, Chofu, Tokyo (Japan)); Inokuti, M. (Argonne National Lab., IL (USA)). *J. Phys., B (London);* **12**: No. 18, 3033-3046(28 Sep 1979).

A comprehensive treatment is presented of integrals of the squared form factor for a fixed transition with respect to the momentum transfer. The integrals with different powers of the momentum transfer are related to different properties calculable from the transition density. Some of the integrals are useful for testing consistency of data obtained from independent sources, either theoretical or experimental. Applications include the integrated cross section for a definite transition, the total inelastic collision cross section, and the polarization (or the angular distribution) of light emitted after collisions, all for impact of fast charged particles for which the first Born approximation is suitable.

24822 **Vibration→vibration energy transfer in methane.** Hess, P.; Kung, A.H.; Moore, C.B. (Department of Chemistry, University of California, Berkeley, California 94720). W-7405-ENG-48. *J. Chem. Phys.;* **72**: No. 10, 5525-5531(15 May 1980).

Vibrational energy levels of methane in the range 2800 to 6000 cm^{-1} were excited by a pulsed tunable laser. Infrared fluorescence decays were observed at 294 K and analyzed to yield V→V energy transfer pathways and rates. Symmetric stretching excitation is converted to asymmetric stretching in the same molecule with a rate constant $k_i 3.6$=(plus-or-minus0.9) x 10^{-11} cm^3 $molecule^{-1}$ s^{-1} (P=0.09). The ν_2 and ν_4 bending vibrations are interconverted somewhat less rapidly. Stretching excitation is converted to bending with a rate constant of (0.8 +- 0.2) x 10^{-11} cm^3 $molecule^{-1}$ s^{-1} (P=0.022) for the stretching fundamentals and about twice that for overtone or combination levels. The rate of almost exactly resonant transfer of a vibrational quantum from one molecule to another was about (1.8 +- 0.6) x 10^{-11} cm^3 $molecule^{-1}$ s^{-1} (P=0.05) for transfer of a bending quantum from $CH_4(2\nu_4)$ and about three times less for transfer of a stretching quantum.

24823 **Collisional ionization of Cs and K by O_2.** Stockdale, J.A.D.; Warmack, R.J. (Chemical Physics Section, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **72**: No. 10, 5673-5678(15 May 1980).

Collisional ionization of Cs and K atoms by O_2 has been studied in a crossed beam geometry from threshold to ~100 eV alkali laboratory system energy. The energy spectra of forward directed positive (Cs^+ and K^+) and negative (O^- and O^-_2) ions were measured by electrostatic energy analysis. The dominant O^-_2 negative ion is associated with forward scattering of the alkali positive ion in the center-of-mass system but O^- production appears associated with backward scattering of the alkali ion.

24824 **Electron-capture collisions at keV energies of boron and other multiply charged ions with atoms and molecules. II. Atomic hydrogen.** Gardner, L.D.; Bayfield, J.E.; Koch, P.M.; Sellin, I.A.; Pegg, D.J.; Peterson, R.S.; Crandall, D.H. (Department of Physics, Yale University, New Haven, Connecticut 06520). *Phys. Rev., A;* **21**: No. 5, 1397-1402(May 1980).

Single electron-capture cross sections have been measured for boron ions B/sup q/+ with initial charges q=2, 3, and 4 incident on an atomic hydrogen target. The cross sections σ_{21} and σ_{43} are large and show little dependence on the ion energy for the range studied, 6q to 23q keV. The cross section σ_{32} increases with increasing energy in this same range. Also reported is a survey of single electron-capture cross sections for ions of carbon (2< or =q< or =4), nitrogen (2< or =q< or =5), and oxygen (2< or =q< or =5) at the single energies 8q keV also incident on atomic hydrogen.

24825 **Time-dependent pair distribution in the mean-field approximation.** Boley, C.D.; Tenti, G. (Applied Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., A;* **21**: No. 5, 1652-1659(May 1980).

The time-dependent pair-distribution function, which plays a central role in the description of nuclear magnetic relaxation and collision-induced absorption in classical fluids, is evaluated in a mean-field approximation proposed earlier. In this scheme the binary dynamics of the colliding pair is treated without approximation, and the interaction with the background fluid is taken into account via a renormalization of the pair potential. The result is expressed in terms of orbits having specified end points and specified elapsed times.

24826 **Charge exchange measurements in helium using a double tandem accelerator-decelerator source of low energy highly stripped oxygen ions.** Bayfield, J.E.; Gardner, L.D.; Gulkok, Y.Z.; Saylor, T.K.; Sharma, S.D. (Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, Pennsylvania 15260). *Rev. Sci. Instrum.;* **51**: No. 5, 651-654(May 1980).

Cross sections for O/sup q/+-He single electron capture have been measured for 5< or =q< or =8 within the energy range 15 to 100 keV per amu. High energy positive ions were injected into an EN tandem Van de Graaff operated at a negative voltage, producing even higher energy for foil stripping to high charge states, followed by ion deceleration to reduce the ion energy by as much as a factor of 50.

24827 **Experimental confirmation of a scaling law for the 1sσ excitation probability for $Z_1+Z_2>120$, and its breakdown in Pb+Cm collisions at very small internuclear distances.** Liesen, D.; Armbruster, P.; Bosch, F.; Hagmann, S.; Mokler, P.H.; Wollersheim, H.J.; Schmidt-Boecking, H.; Schuch, R.; Wilhelmy, J.B. (Gesellschaft fuer Schwerionenforschung, D-6100 Darmstadt, Federal Republic of Germany). *Phys. Rev. Lett.;* **44**: No. 15, 983-986(14 Apr 1980).

The excitation probability of the 1sσ-molecular orbital has been measured as a function of the impact parameter b for several collision systems in the region 129 < or = Z_1+Z_2 < or = 178 at the UNILAC. All published impact-parameter data agree with a simple scaling law except those for impact parameters b< or =40 fm in the Pb+Cm system (Z_1+Z_2=178).

ATOMIC AND MOLECULAR THEORY

24828 **Multiple ionization and x-ray emission accompanying the cascade decay of inner-shell vacancies in Fe.** Jacobs, V.L.; Davis, J.; Rozsnyai, B.F.; Cooper, J.W. (Plasma Radiation Group, Code 6707, Plasma Physics Division, Naval Research Laboratory, Washington D.C. 20375). *Phys. Rev., A;* **21**: No. 6, 1917-1926(Jun 1980).

A model has been developed which predicts the relative abundances of the differently charged ions and the x-ray emission spectra resulting from the cascade decay of an arbitrary distribution of inner-shell vacancies created in atoms by energetic charged particles or x rays. The multiple-ionization and x-ray production cross sections are defined in terms of the populations of the single- and multiple-vacancy states occurring in the atomic reorganization process. All allowed radiative, Auger, and Coster-Kronig transitions are taken into account in the determination of these populations. The x-ray spectra are classified in terms of characteristic lines which are due to the radiative decay of single vacancies and satellites which

are associated with transitions from multiple-vacancy states. Results of calculations are presented for the creation of the initial vacancy distribution by single inner-shell electron ionization of neutral Fe with electrons and photons. Multiple ionization is found to represent only 10% of the total for electron-impact ionization but is predicted to be predominant during K- and L-shell photoionization, in agreement with experimental results obtained for the rare gases. The intensity of the Lα satellites is always less than the Lα characteristic line intensity for electron-impact ionization but can substantially exceed the characteristic line intensity during K-shell photoionization, in agreement with previous results obtained for medium-Z elements.

24829 Complex-basis-function calculations of resolvent matrix elements: Molecular photoionization. McCurdy, C.W.; Rescigno, T.N. (Chemistry Department, Ohio State University, Columbus, Ohio 43210). *Phys. Rev., A;* **21**: No. 5, 1499-1505(May 1980).

Procedures for computing molecular photoabsorption cross sections via finite expansions in sets of L^2 complex basis functions are discussed. Two recently proposed schemes for analytically continuing a matrix representation of the Born-Oppenheimer Hamiltonian are investigated. Both of these matrix analytic continuations are used to compute the parallel component of the photoionization cross section for H_2^+. It is found that to obtain numerically stable results it is necessary to use complex-basis functions which are capable of describing cusps in the molecular wave function at complex values of the coordinates. The application of this technique to larger molecules is also discussed.

24830 Photon statistics in multiphoton absorption and emission processes. Zubairy, M.S.; Yeh, J.J. (Optical Sciences Center, University of Arizona, Tucson, Arizona 85721). *Phys. Rev., A;* **21**: No. 5, 1624-1631(May 1980).

Exact solutions of the master equations which describe single-mode m-photon absorption and m-photon emission processes in a two-level atomic system are obtained using a density-matrix approach. Some aspects of the photon statistics, e.g., antibunching, are discussed.

24831 Manifestation of dynamically unfavored transitions in the angular distribution of photofragments. Greene, C.H. (Department of Physics, University of Chicago, Chicago, Illinois 60637). *Phys. Rev. Lett.;* **44**: No. 13, 869-871(31 Mar 1980).

A class of parity-favored electric dipole transitions are classed as "dynamically unfavored" with a photoparticle angular distribution parameter $\beta \sim -1$. This deviation from the elementary-model value $\beta=2$ results when the squared pseudoscalar operator (j/sub t/ xr)² is nonzero. Herrick's SO(4) classification singles out doubly excited ^{1}P/sup o/ continuum eigenchannels of H^- and He with (j/ sub t/xr)² ~ 0 or ~ 1. Most of the photoelectrons should have (j/ sub t/xr)² ~ 1, i.e., $\beta \sim -1$.

GENERAL FLUID DYNAMICS

REFER ALSO TO CITATION(S) 24974

24832 Nonlinear analysis of laminar boundary layer flow over a periodic wavy surface: Part II: Long waves. Bordner, G.L. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Fluids;* **23**: No. 5, 858-863(May 1980).

The previous analysis of laminar, incompressible flow over a periodic wavy surface is extended to include wavelengths which are large compared with the mean boundary-layer thickness. These larger wavelengths produce a stronger coupling between the outer inviscid flow and the viscous disturbance sublayer and, as a result, require the complete solution of the elliptic inviscid equations. The analysis is refined to allow for a net thickening of the mean boundary layer with increasing wave amplitude. Computer-generated solutions are presented for sinusoidal waves of varying amplitude and wavelength, including cases with local flow separation.

PROPERTIES AND STRUCTURE OF FLUIDS

24833 Bulk viscosity via nonequilibrium and equilibrium molecular dynamics. Hoover, W.G.; Ladd, A.J.C.; Hickman, R.B.; Holian, B.L. (Department of Applied Science, University of California at Davis-Livermore, Livermore, California 94550). W-7405-ENG-48. *Phys. Rev., A;* **21**: No. 5, 1756-1760(May 1980).

Two new nonequilibrium methods for determining the bulk viscosity via molecular dynamics are described. These methods are applied to a soft-sphere dense fluid. Viscosities obtained from the equilibrium Green-Kubo-correlation-function method agree with the nonequilibrium results. The viscosities found are considerably smaller than those predicted by the Enskog theory of dense fluids.

24834 Extension of liquid-metal theory to dense partially ionized plasmas. Ross, M. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3140-3151(15 Apr 1980).

The variational formulation of liquid-metal perturbation theory is generalized to include electronic excitation of the conduction and core electrons. The theory allows calculation of thermodynamic properties for all states from the normal liquid metal to the ionized dense plasma. Theoretical results are compared to experimental shock-compression data and to calculations made by using strongly coupled plasma theory.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

ELECTROMAGNETIC INTERACTIONS

24835 (DOE/ER/03069—770) Search for the production of a new quark flavor at the highest PETRA energies. Barber, D.P.; Becker, U.; Benda, H.; Beohm, A.; Branson, J.G.; Bron, J.; Buikman, D.; Burger, J.D.; Chang, C.C.; Chen, H.S. (Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Nuclear Science). 1980. Contract EY-76-C-02-3069. 17p. NTIS, PC A02/MF A01.

A study of hadron production in e^+e^- collisions at the highest PETRA energies reached so far is reported. Production of a new quark flavor was sought at cms energies of 33, 35, and 35.8 GeV. The measured values of the total cross section, the thrust distributions, and the study of inclusive muon production show no evidence for the production of a new charge 2/3e quark near threshold. In addition, during an energy scan zn the region $29.9 \leq \sqrt{s} \leq 31.6$ GeV, no hadron resonance indicting the existence of a bound state composed of charge 2/3e quarks was bound. 4 figures, 1 table.

24836 Recent results in photoproduction. Cumalat, J.P. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *AIP Conf. Proc.;* **59**: No. 1, 91-116(May 1980). (CONF-7910116—).

From Annual meeting of the American Physical Society; Montreal, Canada (25 Oct 1979).

This paper reviews the recent high energy photoproduction data on vector mesons and charmed mesons.

24837 Recent results from the Mark II detector at SPEAR. Dorfan, J. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-AC03-76SF00515;W-7405-ENG-48. *AIP Conf. Proc.;* **59**: No. 1, 159-184(May 1980). (CONF-7910116—).

From Annual meeting of the American Physical Society; Montreal, Canada (25 Oct 1979).

Recent results from the Mark II Detector at SPEAR are presented. These include measurements of the decays tau⁻→rho⁻ ν/ sub tau/ and tau⁻→K/sup asterisk-/(890)ν/sub tau/, observation of direct photons at the psi, inclusive proton and Λ production and measurements of charmed baryon and charmed meson decays.

24838 Recent results from the crystal ball detector at SPEAR. Peck, C.W.; Partridge, R.; Peck, C.; Porter, F.; Kollmann, W.; Richardson, M.; Strauch, K.; Wacker, K.; Aschman, D.; Burnett, T.; Cavalli-Sforza, M.; Coyne, D.; Sadrozinski, H.; Hofstadter, R.; Kirkbride, I.; Kolanoski, H.; Liberman, A.; O'Reilly, J.; Tompkins, J.; Bloom, E.; Bulos, F.; Chestnut, R.; Gaiser, J.; Godfrey, G.; Kiesling, C.; Oreglia, M. (California Institute of Technology, Pasadena, California 91125). DE-AC-03-79ER0068;DE-03-76SF00515;EY-76-02-3064. *AIP Conf. Proc.;* **59**: No. 1, 185-202(May 1980). (CONF-7910116—).

From Annual meeting of the American Physical Society; Montreal, Canada (25 Oct 1979).

Evidence for an eta/sub c/ candicate with a mass of 2980 +- 15 MeV from the psi' inclusive γ spectrum is presented. The corresponding region in the J/psi inclusive γ spectrum is then studied and shown to be consistent with a broad Breit-Wigner enhancement superimposed upon a smooth background. Results from a detailed study of the two exclusive decay modes psi'→γγ psi→γγ e^+e^- and psi'→γγ psi→γγ$\mu^+\mu^-$ are also given. These consist of measurements of the cascade branching ratios BR(psi'→γchi→γγpsi) for chi(3.55) and chi(3.51) and upper limits on this branching ratio for chi(3.41), chi(3.45), and chi(3.59). Finally, we give branching ratios for the two decays psi'→etapsi and psi'→π °psi.

24839 (LA-tr—80-12) Asymmetry in total scattering of polarized protons by nuclei at 2.1 GeV/s. Zhurkin, V.V.; Ivanchenko, I.M.; Kanavets, V.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). May 1980. Translation of ITEF-24, 1979. 20p. NTIS, PC A02/MF A01.

The results are given for measurements of azimuthal asymmetry in the total (elastic and inelastic without meson formation)

scattering of polarized protons by Li, C, Al, and Ca nuclei in the 0.02 to 0.13 $(GeV/c)^2$ interval of momentum transfer. The data were obtained on the ITEF accelerator for a momentum of 2.1 GeV/c, which is the maximum in this type of research. The experimental results agree with the theoretical notions of the independence of asymmetry on nuclear radius and confirm the suitability of the diffraction theory of multiple scattering using completeness to describe polarization phenomena at high energies.

24840 Measurement of γγpsi final states in psi' decay. Himel, T.M.; Abrams, G.S.; Alam, M.S.; Blocker, C.A.; Boyarski, A.M.; Breidenbach, M.; Burke, D.L.; Carithers, W.C.; Chinowsky, W.; Coles, M.W.; Cooper, S.; Dieterle, W.E.; Dillon, J.B.; Dorenbosch, J.; Dorfan, J.M.; Eaton, M.W.; Feldman, G.J.; Franklin, M.E.B.; Gidal, G.; Goldhaber, G.; Hanson, G.; Hayes, K.G.; Hitlin, D.G.; Hollebeek, R.J.; Innes, W.R.; Jaros, J.A.; Jenni, P.; Johnson, A.D.; Kadyk, J.A.; Lankford, A.J.; Larsen, R.R.; Levi, M.E.; Lueth, V.; Millikan, R.E.; Nelson, M.E.; Pang, C.Y.; Patrick, J.F.; Perl, M.L.; Richter, B.; Roussarie, A.; Scharre, D.L.; Schindler, R.H.; Schwitters, R.F.; Siegrist, J.L.; Strait, J.; Taureg, H.; Tonutti, M.; Trilling, G.H.; Vella, E.N.; Vidal, R.A.; Videau, I.; Weiss, J.M.; Zaccone, H. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-AC03-765-F00515;W-7405-ENG-48. *Phys. Rev. Lett.;* **44**: No. 14, 920-923(7 Apr 1980).

The decay mode psi' → γγpsi has been studied with the Mark-II detector at SPEAR. New measurements of branching ratios for decays of the type psi' → γchi, chi → γpsi involving known chi states are presented. The existence of a chi state of mass near 3455 MeV/c^2 produced in this decay chain is not confirmed, and the upper limit (90% confidence level) of the product of branching ratios is measured to be 0.13%. A new decay mode, psi' → π^0psi, which violates isospin conservation is observed with branching ratio (0.15 +- 0.06)%.

24841 Radiative width of the rho⁻ meson. Berg, D.; Chandlee, C.; Cihangir, S.; Ferbel, T.; Jensen, T.; Lobkowicz, F.; Nelson, C.A.; Ohshima, T.; Slattery, P.; Thompson, P.; Biel, J.; Droege, T.; Jonckheere, A.; Koehler, P.; Heppelmann, S.; Joyce, T.; Makdisi, Y.; Marshak, M.; Peterson, E.; Ruddick, K.; Walsh, T. (University of Rochester, Rochester, New York 14627). *Phys. Rev. Lett.;* **44**: No. 11, 706-709(17 Mar 1980).

The excitation of high-energy pions in the nuclear Coulomb field has been investigated. The data, analyzed assuming the presence of both electromagnetic and strong contributions to coherent production of $\pi^-\pi^0$ systems, yield a decay width for rho⁻ → $\pi^-\gamma$ of 67 +- 7 keV.

24842 Decay J/π → 3γ and a search for the eta/sub c/. Partridge, R.; Peck, C.; Porter, F.; Kollman, W.; Richardson, M.; Strauch, K.; Wacker, K.; Aschman, D.; Burnett, T.; Cavalli-Sforza, M.; Coyne, D.; Sadrozinski, H.; Bloom, E.; Bulos, F.; Chestnut, R.; Gaiser, J.; Godfrey, G.; Kiesling, C.; Oreglia, M.; Hofstadter, R.; Kirkbride, I.; Kolanoski, H.; Liberman, A.; O'Reilly, J.; Tompkins, J. (Physics Department, California Institute of Technology, Pasadena, California 91125). DE-AC-3076SF00515;EY-76-C02-3064;EY-76-C03-0068. *Phys. Rev. Lett.;* **44**: No. 11, 712-716(17 Mar 1980).

The decay J/psi into 3γ final states has been studied. No evidence is found for the existence of the X(2.83) or any heavy narrow state (e.g., the eta/sub c/) decaying into two photons. Upper limits are given on the branching ratio J/psi → eta/sub c/,eta/sub c/ → 2γ for eta/sub c/ masses in the 2.7—3.0-GeV region. In addition, the branching ratios J/psi → γeta,γeta' are measured. It is found that the eta' branching ratio is higher than previously reported.

24843 New upper limit for the C-noninvariant decay π^0 → 3γ. Highland, V.L.; Auerbach, L.B.; Haik, N.; McFarlane, W.K.; Macek, R.J.; Pratt, J.C.; Sarracino, J.; Werbeck, R.D. (Physics Department, Temple University, Philadelphia, Pennsylvania 19122). *Phys. Rev. Lett.;* **44**: No. 10, 628-631(10 Mar 1980).

A new search for three-photon decays of the neutral pion has been made. No signal in excess of background was observed. The upper limit for the π^0 → 3γ branching ratio is 3.8 x 10^{-7} (90% confidence level).

24844 (DOE/ER/10516—T2) New optimal polynomial theory for NN-scattering. Rijken, T.A.; Signell, P. (Michigan State Univ., East Lansing (USA). Dept. of Physics). [nd]. Contract AC02-79ER10516. 36p. NTIS, PC A03/MF A01.

A new optimal polynomial theory for nucleon-nucleon scattering is presented. For the first time in nucleon-nucleon scattering, the derivative amplitudes originally introduced by Fubini, Furlan, and Rosetti are applied. Based on the properties of these amplitudes we introduce K-matrix functions which have suitable analyticity properties as functions of cos θ, where θ is the center of mass scattering angle. The K-matrix functions enable introduction of a new set of functions for which the optimal mapping techniques of Cutkosky, Deo and Ciulli can be applied. Results are shown for proton-proton phase shift analyses at 210 and 330 MeV.

WEAK INTERACTIONS

24845 Measurement of charmed particle lifetimes. Reay, N.W. (Ohio State University, Columbus, Ohio). *AIP Conf. Proc.;* **59**: No. 1, 77-90(May 1980). (CONF-7910116—).

From Annual meeting of the American Physical Society; Montreal, Canada (25 Oct 1979).

This talk briefly reviews recent measurements of charmed particle lifetimes, then presents in detail the lifetime measurements of Fermilab Experiment 531.

24846 (LBL—10801) Decays of the heavy lepton, tau (1785). Blocker, C.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 127p. NTIS, PC A07/MF A01.

Thesis.

The structure of the weak hadronic current coupled to the tau is investigated via some of the hadronic decays of the tau. The vector current coupling is determined by measuring the tau → rho ν/sub tau/ branching ratio. The axial-vector coupling is determined by measuring the tau → π ν/sub tau/ branching ratio. The Cabibbo structure of the hadronic current is established by observing the decay tau → K*(890)ν/sub tau/ and measuring its branching ratio. The branching ratios for the decays tau → e anti ν/sub e/ν/sub tau/ and tau → μ anti ν/sub μ/ν/sub tau/ are measured as a normalization for the hadronic decays and as a check on the validity of the measurements. The leptonic branching ratios agree well with previous experiments. From a kinematic fit to the pion energy spectrum in the decay tau → π ν/sub tau/, an upper limit (95% confidence level) of 245 MeV is placed on the tau neutrino mass. From a simultaneous fit of the center of mass energy dependence of the tau production cross section and the pion energy spectrum in the decay tau → π ν/sub tau/, the tau mass is determined to be 1.787 +- .010 GeV/c. All properties of the tau measured here are consistent with it being a sequential lepton coupled to the ordinary weak hadronic current.

24847 Search for the violation of time-reversal invariance in K⁰/sub mu3/ decays. Morse, W.M.; Leipuner, L.B.; Larsen, R.C.; Schmidt, M.P.; Blatt, S.R.; Campbell, M.K.; Grannan, D.M.; Lauterbach, M.J.; Kasha, H.; Adair, R.K. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **21**: No. 7, 1750-1766(1 Apr 1980).

The transverse polarization of muons from the decay K⁰/sub L/ → $\pi^-\mu^+$ ν/sub μ/ has been recently measured at Brookhaven National Laboratory. A cylindrically symmetric detector was employed with scintillation-counter hodoscopes detecting the charged decay products of the in-flight kaon decay and determining the orientation of the decay plane in the laboratory. Muons were brought to rest in an aluminum polarimeter where they precessed in 60-G magnetic field. The muon polarization was determined from the asymmetric emission of the positron in the muon decay (μ^+ → e^+ ν/sub e/nu-bar/sub μ/). With 12 x 10^6 events collected the mean values measured for the two components of transverse polarization are P/sup lab//sub n/=0.0017 +- 0.0056 for the component normal to the decay plane and P/sup lab//sub t/=0.417 +- 0.063 for the component in the decay plane. For Imξ, where ξ is the ratio of form factors describing K/sub mu3/ decay, we have deduced a value of 0.009 +- 0.030 which is not significantly different from the value 0.008, expected if time-reversal invariance is valid. We deduce that the average value of the ratio of the normal to transverse components of muon polarization in the kaon rest frame is given by < P/sub n//P/sub t/ > /sup c.m./=0.005 +- 0.015.

24848 Measurement of the cross section for ν/sub μ/+e⁻ → ν/sub μ/+e⁻. Heisterberg, R.H.; Mo, L.W.; Nunamaker, T.A.; Lefler, K.A.; Skuja, A.; Abashian, A.; Booth, N.E.; Chang, C.C.; Li, C.; Wang, C.H. (Department of Physics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061). *Phys. Rev. Lett.;* **44**: No. 10, 635-639(10 Mar 1980).

A total of ~ 249 000 neutrino interactions were observed at Fermilab in a high—angular-resolution electromagnetic shower detector, with ~ 0.947 x 10^{19} protons of 350-GeV energy incident upon the production target. Based on a data sample of 0.71 x 10^{19} protons, 46 electrons were observed with θ/sub e/ < or = 10 mrad. Of these 46 events, 34 are attributed to the process ν/sub μ/+e⁻ → ν/sub μ/+e⁻, and 12 are attributed to background processes. This leads to the following results; σ1.40=(ts +- 0.30) x 10^{-42}E/sub ν/ cm^2, and $\sin^2\theta$/sub W/=0.025/sup +0.07//sub -0.05/.

24849 High statistics measurement of the vector and axial vector coupling constraints in lambda beta decay. Wise, J. Amherst, MA; Univ. of Massachusetts (1979). 135p. University Microfilms Order No. 79-12,731.

Thesis (Ph. D.).

A high-statistics measurement, using approximately 10,000 events, of the branching ratio and the ratio of axial vector to vector coupling, g_1/f_1, for Λ^0 beta decay was performed at Brookhaven National Laboratory with a tandem magnetic spectrometer. Values of branching ratio = .84 +- .06 x 10^{-3} and g_1/f_1 = .90 +- .17 were

measured. These numbers are consistent with the Cabibbo model of weak interactions based on SU(3) unitary symmetry and other experiments. The errors quoted include an estimate of systematic effects. As understanding of these effects continues to improve, errors will shrink.

STRONG BARYON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 24837

24850 Sources of prompt leptons in hadronic collisions. Bodek, A. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). EY-76-C-02-3065. *AIP Conf. Proc.;* **59**: No. 1, 211-246(May 1980). (CONF-7910116—).

From Annual meeting of the American Physical Society; Montreal, Canada (25 Oct 1979).

Experimental evidence for various sources of prompt leptons produced in hadronic collisions is discussed. Emphasis is placed on sources of prompt single leptons and prompt multileptons. Such final states are expected from production and subsequent weak decays of short lived states. Hadronic charm production cross sections of 20 μb per nucleon at 400 GeV account for the observed single lepton signal as well as dileptons with missing energy (indicative of final state neutrinos). Limits of 40 μb/nucleon for bottom particle production in 400 GeV proton collisions are extracted from multimuon final state signatures. Various prompt dilepton sources (such as Drell-Yan and resonance production) are also summarized.

24851 Observation of hadronic charm production in a high resolution streamer chamber experiment. Sandweiss, J.; Cardello, T.; Cooper, P.; Kellogg, R.; Ljung, D.; Ludlam, a.; Majka, R.; McBride, P.; Nemethy, P.; Rosselet, L.; Slaughter, A.J.; Taft, H.D.; Teig, L.; Tzeng, L.; Ecklund, S.; Johnson, M. (Yale University, New Haven, Connecticut 06520). *AIP Conf. Proc.;* **59**: No. 1, 247-262(May 1980). (CONF-7910116—).

From Annual meeting of the American Physical Society; Montreal, Canada (25 Oct 1979).

Cross section and lifetimes were obtained for the production of charmed particles by the interactions of 350-GeV protons with Ne and He. (AIP)

STRONG MESON-INDUCED INTERACTIONS

24852 Search for narrow p-barp states in the reaction $\pi^+ p \rightarrow \Delta/sub\ f/^{++}$ p-barp. Bionta, R.M.; Carroll, A.S.; Edelstein, R.M.; Green, D.R.; Makuchowski, E.J.; Morrissey, S.P.; Russ, J.S.; Russell, J.J.; Sharfman, N.; Sutton, R.B. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **44**: No. 14, 909-912(7 Apr 1980).

The results of a search for narrow p-barp states produced in the baryon-exchange reaction $\pi^+ p \rightarrow \Delta/sub\ f/^{++}$ p-barp at 9.8 GeV/c are reported. This channel provides an enhanced sensitivity to such states compared with the reaction $\pi^- p \rightarrow \Delta/sub\ f/^{0}$ p-barp. We find no evidence for such states at the 20—30-nb level in the mass range 1.9—2.3 GeV/c^2. Assuming a nucleon-exchange production mechanism, the states which have been reported in $\pi^- p$ interactions at 2.02 and 2.20 GeV/c^2 would appear as >5-standard-deviation peaks in this data.

24853 Measurement of radiative $\pi^+ p$ scattering below the $\Delta^{++}(1232)$ resonance. Smith, D.E.A.; Glodis, P.F.; Haddock, R.P.; Leung, K.C.; Tamor, M.A. (University of California, Los Angeles, California 90024). EY-76-03-0010-PA25. *Phys. Rev., D;* **21**: No. 7, 1715-1725(1 Apr 1980).

We report measurements of $\pi^+ p \rightarrow \pi^+ p\gamma$ at 17 photon angles for 165-MeV incident pions. Like the previously reported data for 269-, 298-, and 324-MeV incident pions, these data show little structure and do not deviate significantly from models predicting a monotonic decrease of the photon energy spectra with increasing photon energy.

24854 Leading particles and diffraction dissociation in 150-GeV/c $\pi^- p$ interactions. Brick, D.; Fong, D.; Heller, M.; Shapiro, A.M.; Widgoff, M.; Bruyant, F.; Lucas, P.; Bogert, D.; Johnson, M.; Burnstein, R.; Fu, C.; Petersen, D.; Robertson, D.; Rubin, C.; Sard, R.; Snyder, A.; Tortora, J.; Alyea, E.D. Jr.; Chien, C.; Pevsner, A.; Zdanis, R.; Barriero, F.; Benary, O.; Brau, J.F.; Grunhaus, J.; Hafen, A.S.; Hulsizer, R.I.; Karshon, U.; Kistiakowsky, V.; Levy, A.; Napier, A.; Pless, I.A.; Silvermann, J.P.; Trepagnier, P.C.; Wolfson, J.; Yamamoto, R.K.; Cohn, H.O.; Jacques, P.F.; Ou, T.C.; Plano, R.J.; Watts, T.L.; Brucker, E.; Koller, E.L.; Stamer, P.E.; Taylor, S.; Bugg, W.; Condo, G.; Handler, T.; Hart, E.; Kraybill, H.; Ljung, D.; Ludlam, I.; Taft, C.D. (Brown University, Providence, Rhode Island 02912). *Phys. Rev., D;* **21**: No. 7, 1726-1743(1 Apr 1980).

Diffraction dissociation of both the beam and target particles has been observed in 150-GeV/c $\pi^- p$ interactions in the Fermilab 30-in.-bubble-chamber—proportional-wire-chamber hybrid spectrometer. The dissociations are observed as recoil systems opposite leading particles, the signals of which are separated from background where appropriate by a variant of the Van Hove sector cut, thus allowing the high-mass portion of the spectrum to be observed. Pion dissociation has a cross section of 1758 +- 105 μb, divided among two-, four-, and six-prong events; some rho^0 production is seen and comes primarily from the $\pi^- \rightarrow 2\pi^-\pi^+$ channel. The proton dissociation cross section is 1726 +- 100 μb, again divided among two-, four-, and six-prong events. The final state contains a neutron more frequently than a proton in the two- and six-prong events, a proton more frequently in the four-prong events. Production of Δ^{++} is observed in the $p \rightarrow p\pi^+\pi^-$ dissociations.

24855 Investigation of higher-mass even-G states from 15-GeV/c $\pi^+ d$ collisions. Bugg, W.M.; Condo, G.T.; Handler, T.; Hart, E.L.; Cohn, H.O.; Hagopian, S.; Hagopian, V.; Lannutti, J.E.; Wind, B. (Department of Physics, University of Tennessee, Knoxville, Tennessee 37916). *Phys. Rev., D;* **21**: No. 7, 1744-1749(1 Apr 1980).

From a study of 15-GeV/c π^+-deuterium interactions obtained in an 890 000-picture exposure in the SLAC 82-in. bubble chamber, evidence is presented for at least two broad dipion states beyond the g(1680) region. These states appear in the spectrum representing highly peripheral interactions, and in the spectra obtained by eliminating those interactions for which the transverse momentum of each pion is less than a specified minimum value. Further, examination of the $\pi^+\pi^-$MM (missing mass) spectrum from the reaction $\pi^+ n \rightarrow p\pi^+\pi^-$(MM) indicates that agreement with the previously obtained branching ratios is possible only if higher-mass dipion states are present. Evidence is also presented which suggests a finite decay probability of the g (or a state of similar mass) into $\pi^+\pi^-$ eta and/or $\pi^+\pi^-$ eta'.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

REFER ALSO TO CITATION(S) 24800, 24878, 24880, 24882

24856 Dual formulation of non-Abelian gauge theories. Kazama, Y.; Savit, R. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **21**: No. 10, 2916-2925(15 May 1980).

Motivated by an analogy with Abelian theories, we construct a new duality transformation for non-Abelian gauge theories. For large coupling the gauge-theory vacuum should have its most important contributions from configurations of the dual fields without large fluctuations. The generating functional when expressed in terms of the dual variables has a rather simple and suggestive structure which manifests some features of a gauge theory, but now a gauge theory of the dual variables with the coupling constant inverted. We discuss several aspects of this representation including the possibility of using it as the basis for a strong-coupling expansion for the field theory. We also investigate a systematic, formal (perturbative) solution to a constraint condition among our dual variables which has the form of a Bianchi identity.

24857 Simple quantum-chromodynamic parametrizations of parton distributions beyond the leading order of asymptotic freedom. Bialas, A.; Buras, A.J. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510 with the U.S. Dept. of Energy.). *Phys. Rev., D;* **21**: No. 7, 1825-1833(1 Apr 1980).

It is shown that the Q^2 dependence of the nonsinglet (NS) parton distributions in quantum chromodynamics with leading- and next-to-leading-order corrections included can be adequately represented by simple analytic expressions, similar to those proposed by Gaemers and one of the authors. The pattern of higher-order corrections to the Q^2 dependence of $F/sup\ NS/_2(x,Q^2)$ and of $F_3(x,Q^2)$ is discussed.

24858 Reggeization of elementary fermions in arbitrary renormalizable gauge theories. Grisaru, M.T.; Schnitzer, H.J. (Department of Physics, Brandeis University, Waltham, Massachusetts 02254). E(11-1)3230. *Phys. Rev., D;* **21**: No. 7, 1952-1965(1 Apr 1980).

An arbitrary, renormalizable non-Abelian gauge theory with gauge group G and arbitrary scalar and fermion structure is considered. Necessary conditions for all the fermions of the theory to lie on Regge trajectories are derived. If no fermion transforms as a singlet under G, then all fermions Reggeize. If some fermions transform as singlets under G, then certain group-theoretic constraints on the fermion mass matrix must be satisfied if all fermions are to Reggeize. These methods are applied to the Weinberg-Salam and grand unified theories. As a by-product of this study, kinematical-singularity-free, signatured helicity amplitudes are constructed which allow for P and CP violation. Such amplitudes may be useful for applications outside the context of the Regge program.

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 24884

24859 Background to neutrino counting in e^+e^- collisions. Dicus, D.A. (Center for Particle Theory, University of Texas, Austin, Texas 78712). *Phys. Rev., D;* **21**: No. 7, 1767-1770(1 Apr 1980).

The background from $e^+e^- \rightarrow 3\gamma$ to the proposed neutrino-counting process of $e^+e^- \rightarrow \gamma\nu\text{nu-bar}$ is calculated. It is shown that at PEP or PETRA beam energies (15—18 GeV) the 3γ cross section is at least three orders of magnitude greater than the $\gamma\nu\text{nu-bar}$ cross section. At higher beam energies, near the Z pole, the $\gamma\nu\text{nu-bar}$ cross section is larger than the background but other ambiguities may make a determination of the number of types of neutrinos very difficult.

24860 K/sub S/^{0*} and its uses. Littenberg, L.S. (Brookhaven National Laboratory, Upton, New York 11973). EY-76-C-02-0016. *Phys. Rev., D;* **21**: No. 7, 2027-2028(1 Apr 1980).

We point out that Primakoff conversion of K/sub L/^{0}'s produces K^{0*}/sub S/'s. This makes possible a practical tagged K/sub S/^{0} beam. In addition one can test the recent suggestion that I=1 exchange effects necessitate large corrections to Primakoff measurements of vector-meson electromagnetic widths. It will also be possible to measure $\Gamma(K^{0*} \rightarrow K^0\gamma)$ in a manner independent of the alleged corrections.

WEAK INTERACTIONS

24861 (BNL—27615) Flavor mixing and charm decay. Chau Wang, L.C. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 20p. (CONF-800120—3). NTIS, PC A02/MF A01.

From Conference on theoretical particle physics; Guangchou, China (5 Jan 1980).

The results of mixing matrix determination and their implications on heavy quark decays are given. The decays of charm mesons D^0, D^+, F^+ into two pseudoscalar mesons are discussed in the framework of SU(3) symmetry. The charm decays are also discussed in terms of quark diagrams. It is demonstrated that the differences observed in the lifetimes of D^0 and D^+, and in the branching ratios $B(D^0 \rightarrow K^-K^+)$ and $B(D^0 \rightarrow \pi^-\pi^+)$ can be easily incorporated. 3 figures.

24862 QCD phenomenology of deep-inelastic scattering. Abbott, L.F. (Brandeis University, Waltham, Massachusetts 02254). DE-AC03-76SF00515;E(11-1)3230. *AIP Conf. Proc.;* **59**: No. 1, 311-324(May 1980). (CONF-7910116—).

From Annual meeting of the American Physical Society; Montreal, Canada (25 Oct 1979).

The role of higher-twist effects and corrections of non-leading order in α/sub s/ in the QCD phenomenology of deep-inelastic scattering is discussed. The possibility of higher-twist effects accounting for the anomalously large ratio of longitudinal to transverse electroproduction cross sections is examined.

24863 (LA-tr—80-11) Weak interaction of nucleons in the Weinberg-Salam model. Lobov, G.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). May 1980. Translation of ITEF-29, 1979. 20p. NTIS, PC A02/MF A01.

Weak interaction potentials of nucleons due to exchange of non-eta vector mesons are obtained in the Weinberg-Salam model using vector dominance. The contribution of neutral hadron currents to the weak interaction potential due to exchange of charged π mesons is evaluated. The isotopic structure of the derived potentials, which in the Weinberg-Salam model is defined unambiguously, is investigated. The intensification of the effects of weak interaction of nucleons in nuclei caused by the contributions of neutral hadron currents is discussed. The nuclear one-particle weak interaction potential, which is obtained from the two-particle potential by averaging over the states of the core of the nucleus, is given. An approach to the weak interaction of nucleons based on the quark model is discussed.

24864 What can we learn about nuclear electric dipole moments from parity nonconservation in atomic transitions?. Epstein, G.N. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). EY-76-C-02-3069. *Phys. Rev. Lett.;* **44**: No. 14, 905-908(7 Apr 1980).

We show that in parity nonconservation experiments currently underway on hydrogen and deuterium, the limits on the proton and deuteron electric dipole moments may be improved by as much as two and nine orders of magnitude, respectively. The situation for heavier atoms is briefly examined.

24865 Addendum to "Hadronic corrections to the annihilation rateof heavy vector mesons to lepton pairs". Poggio, E.C.; Schnitzer, H.J. (MIT Lincoln Laboratory, P.O. Box 73, Lexington, Massachusetts 02173). E(11-1)3230. *Phys. Rev., D;* **21**: No. 7, 2034-2035(1 Apr 1980).

Further discussion of the hadronic corrections to the van Royen—Weisskopf formula is presented.

24866 Troubles with nonleptonic charm decays. Lipkin, H.J. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev. Lett.;* **44**: No. 11, 710-712(17 Mar 1980).

Conclusions about weak interactions from nonleptonic D^0 decays are completely changed by strong final-state interactions. The suppression of $D^0 \rightarrow K\text{-bar}^0\pi^0$ found in some models is completely reversed to $\Gamma(D^0 \rightarrow K\text{-bar}^0\pi^0) = 8\Gamma(D^0 \rightarrow K^-\pi^+)$ by introduction of experimentally measured $K\pi$ scattering phase shifts in the exotic I=3/2 and nonexotic I=1/2 amplitudes. The $K^+K^-/\pi^+\pi^-$ ratio is very sensitive to meson resonances expected at the D mass. Predictions less sensitive to final state interactions are discussed.

STRONG INTERACTIONS, GENERAL

REFER ALSO TO CITATION(S) 24866

24867 (DOE/ER/01545—274) Zero-point energy of confined fermions. Milton, K.A. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1980. Contract AC02-76ER01545. 23p. NTIS, PC A02/MF A01.

A closed form for the reduced Green's function of massless fermions in the interior of a spherical bag is obtained. In terms of this Green's function, the corresponding zero-point or Casimir energy is computed. It is proposed that a resulting quadratic divergence can be absorbed by renormalizing a suitable parameter in the bag model (that is, absorbed by a contact term). The residual Casimir stress is attractive, but smaller than the repulsive Casimir stress of gluons in the model. The result for the total zero-point energy is in substantial disagreement with bag model phenomenological values.

24868 Heavy quarks and new particles. Rosner, J.L. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). EY-76-C-02-1764. *AIP Conf. Proc.;* **59**: No. 1, 325-352(May 1980). (CONF-7910116—).

From Annual meeting of the American Physical Society; Montreal, Canada (25 Oct 1979).

Some aspects of particles containing c, b, and heavier quarks are reviewed. It is shown how these particles can provide tests of the short-range nature of the strong interactions, and how elementary quantum mechanics can reveal the color and charge of the constituents and the number of states below flavor threshold. Some new results are presented on the inverse problem for confining potentials. Properties of flavored hadrons (masses and lifetimes), of gluonic bound states, and of particles containing very heavy objects are also discussed.

24869 Recombination model and multimeson production. Takasugi, E.; Tata, X. (Center for Particle Theory, Department of Physics, University of Texas, Austin, Texas 78712). EY-76-S-05-3992. *Phys. Rev., D;* **21**: No. 7, 1838-1841(1 Apr 1980).

The recombination model with Kuti-Weisskopf multiquark structure functions leads to a new power-counting rule for multimeson inclusive spectra in the small-p/sub T/ domain. The parameter-free predictions for the $\pi^+\pi^+$ and $\pi^-\pi^-$ inclusive spectra are in good agreement with the UCLA-Saclay data.

STRONG INTERACTIONS, BARYON NO.=0

REFER ALSO TO CITATION(S) 24818, 24861

24870 Pion and an improved static bag model. Donoghue, J.F.; Johnson, K. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). EY-76-C-02-3069. *Phys. Rev., D;* **21**: No. 7, 1975-1985(1 Apr 1980).

Quark-model calculations involve an extended static object localized in space. We introduce new methods, involving momentum-space wave packets, which account for this localization. These methods have little effect on heavy states, whose sizes are large compared to their Compton size 1/m, but are very important for light particles such as the pion. In this treatment the pion's mass is naturally very small, and, in order to connect with a spontaneously broken chiral symmetry, we require that m/sub π/ vanish when the light quarks are massless. Expanding about this limit (and also readjusting the fit to other hadrons), we obtain m/sub q/=(m-italic/sub u/+m/sub d/)/2=33 MeV. We calculate F/sub π/ $\simeq$ 145 MeV (using a normalization such that F/sub π/ vertical-bar /sub exp/ =93 MeV), F/sub K//F/sub π/ $\simeq$ 1, and various corrections to static properties of baryons. In addition we explore the relationship of our methods with chiral perturbation theory, deriving the formula m/sub π/ ^{2}=(m-italic/sub u/+m/sub d/) $<$ π(p) vertical-bar q-bar(0)q(0) vertical-bar π(p) $>$ in the appropriate approximation and

commenting on the quark mass obtained from the nucleon's σ term. Finally we discuss the bag model's use of the scalar density q-barq as an order parameter describing the separation of the spontaneously broken vacuum phase from the perturbative vacuum of the bag's interior.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

24871 (DOE/ER/10516—T3) **Optimized polynomial expansions: potentials and phase shift analyses.** Marker, D.; Rijken, T.; Bohannon, G.; Signell, P. (Hope Coll., Holland, MI (USA); Michigan State Univ., East Lansing (USA). Dept. of Physics). 18 Mar 1980. Contract AC02-79ER10516. 18p. NTIS, PC A02/MF A01.

The Cutkosky-Deo-Ciulli-Chao Optimized Polynomial Expansion as applied to the proton-proton scattering amplitudes was examined. Chao's positive numerical results for intermediate energy scattering data could not be reproduced. Instead, a negative conclusion as to the method's usefulness for that application was reached. Source(s) of the discrepancies with Chao's results could not be located definitely, but there were indications of a problem with a relative phase. The ability of the method to predict the higher angular momentum parts of the amplitudes for three different potentials having realistic parts was also examined. Again, the method was found to have very meager successes. 7 tables.

24872 **Widths of Σ-hypernuclear states.** Kisslinger, L.S. (Physics Department, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). DE-AC02-76CH00016. *Phys. Rev. Lett.;* **44**: No. 15, 968-971(14 Apr 1980).

The widths of states of Σ-hypernuclei have been estimated in two models. Widths as small as one to a few megaelectronvolts are found, a result which should hold for some isolated simple Σ-hypernuclear states. The standard procedure by use of the two-body absorptive cross section is shown to overestimate the width by one or more orders of magnitude.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

GENERAL

REFER ALSO TO CITATION(S) 24877

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 24843, 24847

24873 **Gauge models of CP violation.** Wolfenstein, L. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *AIP Conf. Proc.;* **59**: No. 1, 365-372(May 1980). (CONF-7910116—).

From Annual meeting of the American Physical Society; Montreal, Canada (25 Oct 1979).

Experimental consequences of milliweak gauge models of CP violation that may distinguish them from superweak are discussed. Included are eta$_{00}$ in $K^0 \to 2\pi$ decay, eta/sub +/-0 in $K^0 \to 3\pi$ decay, and the electric dipole moment of the neutron. Emphasis is on the six-quark SU(2) x U(1) model (Kobayashi—Maskawa CP violation).

24874 **Exotic new quarks and dynamical symmetry breaking.** Marciano, W.J. (The Rockefeller University, New York, New York 10021). EY-76-C-02-2232B.000. *Phys. Rev., D;* **21**: No. 8, 2425-2428(15 Apr 1980).

Exotic quarks belonging to 6, 8, 10, or higher representations of SU(3)/sub c/ (quantum chromodynamics) naturally interact more strongly than conventional 3-plet quarks. Therefore, chiral-symmetry breaking in exotic quark sectors may occur at much larger mass scales than ordinary chiral-symmetry breaking. If those mass scales are about 10^3 times larger, then when appended to the Weinberg-Salam model exotic quark-antiquark bound-state condensates could dynamically break the flavor SU(2) x U(1) gauge symmetry and produce viable W^{+-} and Z^0 masses which satisfy M/sub W/ = M/sub Z/cosθ/sub W/. Features of this scenario are described.

FIELD THEORY

REFER ALSO TO CITATION(S) 24799, 24842, 24856, 24857, 24858, 24862, 24868, 24870, 24874, 24942

24875 (BNL—27617) **Baecklund transformations, conservation laws and linearization of the self-dual Yang-Mills and chiral fields.** Wang, L.C. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 26p. (CONF-800120—4). NTIS, PC A03/MF A01.

From Conference on theoretical particle physics; Guangchou, China (5 Jan 1980).

Baecklund Transformations (BT) and the derivation of local conservation laws are first reviewed in the classic case of the Sine-Gordon equation. The BT, conservation laws (local and nonlocal), and the inverse-scattering formulation are discussed for the chiral and the self-dual Yang-Mills fields. Their possible applications to the loop formulation for the Yang-Mills fields are mentioned. 55 references, 1 figure.

24876 (COO—3075-224) **Dynamical criteria for a unified gauge theory (including gravity).** (Yale Univ., New Haven, CT (USA). Dept. of Physics). 1979. Contract EY-76-C-02-3075. 36p. (CONF-7905150—1). NTIS, PC A03/MF A01.

From 3. workshop on current problems in high energy particle theory; Florence, Italy (30 May 1979).

It is shown that local gauge invariance together with dynamical (and possibly Higgs) symmetry breaking can be taken as a basis for a unified gauge theory including gravity. The criterion for the breakdown of the linear gauge symmetry of the space-time sector turns out to be the absence of a prior geometry. The usual postulates of general relativity, such as general coordinate invariance, etc., follow from the above two criteria. Gravity actions that are natural from the point of view are discussed. The extension to superspace relevant to gauge supergroups is also given, including a large number of linear and quadratic superspace invariants.

24877 **Simple connection between conservation laws in the Korteweg—de Vriesand sine-Gordon systems.** Chodos, A. (Department of Physics, Yale University, New Haven, Connecticut 06520). EY-76-C-02-3075. *Phys. Rev., D;* **21**: No. 10, 2818-2822(15 May 1980).

An infinite sequence of conserved quantities follows from the Lax representation in both the Korteweg—de Vries and sine-Gordon systems. We show that these two sequences are related by a simple substitution. In an appendix, two different methods of deriving conservation laws from the Lax representation are presented.

24878 **Orthogonal transforms and lattice field theories.** Blankenbecler, R.; Richardson, J.L. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-AC03-76SF00515. *Phys. Rev., D;* **21**: No. 10, 2867-2877(15 May 1980).

In a previous paper we showed that a class of real-space renormalization-group calculations could be reinterpreted as an orthogonal transformation of coordinates followed by an approximate (variational) evaluation of the resulting Hamiltonian. Here we shall discuss the orthogonal-transform method and concentrate on analytic rather than numerical results. The transform method may ultimately be more accurate because even though similar approximations are made in coupling the lattice oscillators, at no time is the system split into noninteracting finite-sized blocks. Approximate variational solutions to a phi^4 lattice field theory in 2, 3, and 4 space-time dimensions are constructed using an anharmonic-oscillator basis. The solutions exhibit an ordered and a disordered phase. Analytic expressions are obtained for certain critical surfaces of these theories in regions of parameter space where a spin approximation would be invalid. The continuum limit of our solutions is discussed. The resultant perturbation expansion is also discussed and a method for its evaluation is described.

24879 **Phase diagram of Z(N) and U(1) gauge theories in three dimensions.** Bhanot, G.; Creutz, M. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). DE-AC02-76CH00016. *Phys. Rev., D;* **21**: No. 10, 2892-2902(15 May 1980).

We present Monte Carlo studies of Z(N) and U(1) lattice gauge theories in three space-time dimensions. The Z(N) gauge theory is analyzed via its dual spin system. We find that Z(N) has one phase transition that moves to zero temperature as $N \to \infty$. The U(1) theory has only a single, confining phase. A study of Wilson loops in Z(8) shows that the coefficient of the area law vanishes for all temperatures below the critical temperature. No such zero is seen in the string tension for U(1) gauge theory. We also study the U(1) gauge theory in five dimensions and see a clear signal for a first-order phase transition.

24880 **Simple model of the ground state of quantum chromodynamics.** Johnson, K. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-AC03-76SF00515. *AIP Conf. Proc.;* **59**: No. 1, 353-364(May 1980). (CONF-7910116—).

From Annual meeting of the American Physical Society; Montreal, Canada (25 Oct 1979).

A proposal for the form of the ground state wave function of quantum chromodynamics is made. It is shown to lead to the phenomenology of the MIT Bag model. The parameters of this model are related to the fundamental scale parameter of QCD.

24881 **Monte Carlo study of quantized SU(2) gauge theory.** Creutz, M. (Department of Physics, Brookhaven National Labora-

tory, Upton, New York 11973). *Phys. Rev., D;* **21**: No. 8, 2308-2315(15 Apr 1980).

Using Monte Carlo techniques, we evaluate path integrals for pure SU(2) gauge fields. Wilson's regularization procedure on a lattice of up to 10^4 sites controls ultraviolet divergences. Our renormalization prescription, based on confinement, is to hold fixed the string tension, the coefficient of the asymptotic linear potential between sources in the fundamental representation of the gauge group. Upon reducing the cutoff, we observe a logarithmic decrease of the bare coupling constant in a manner consistent with the perturbative renormalization-group prediction. This supports the coexistence of confinement and asymptotic freedom for quantized non-Abelian gauge fields.

24882 1/N expansion and the theory of composite particles. Shizuya, K. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **21**: No. 8, 2327-2335(15 Apr 1980).

Dynamical structures of nonlinear spinor and bosonic theories are studied in the framework of the 1/N expansion. It is shown that a wide class of four-fermion theories contains composite particles and that they can be cast into equivalent field theories with the so-called compositeness condition. With the formation of composite particles, the ultraviolet behavior of a large class of four-fermion theories is improved so that they become renormalizable and well-defined field theories beyond two (but less than four) dimensions in spite of their apparent nonrenormalizability in the conventional perturbation expansions.

24883 Quantum-mechanical fluctuations of the resonance-radiation force. Cook, R.J. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). W-7405-ENG-48. *Phys. Rev. Lett.;* **44**: No. 15, 976-979(14 Apr 1980).

The influence on atomic motion of quantum-mechanical fluctuations of the resonance-radiation force is investigated theoretically. Fluctuations due to both induced and spontaneous absorption-emission processes give rise to diffusion of atomic momentum, here described by a Fokker-Planck equation. It is shown that quantum-mechanical fluctuations of the radiation force place a lower bound on the temperature achievable by radiation cooling, inhibit cooling in a strong standing wave, and lead to finite, often short, confinement times for atoms in radiation traps.

24884 Process dependence of perturbative quantum-chromodynamic jet structures. Gottschalk, T.; Monsay, E.; Sivers, D. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **21**: No. 7, 1799-1824(1 Apr 1980).

We examine the structure of elementary $2 \rightarrow 3$ processes involving leptons, quarks, and gluons, as calculated to lowest nontrivial order in the perturbation series for quantum chromodynamics. Particular attention is devoted to the canonical mass-singularity structure of these perturbative expressions along the borders of phase space, since it is precisely the residues of these poles which yield the asymptotic ratio $C_2(G)/C_2(R)$ for the widths of gluon/quark jets. We find, however, that the extent to which this simple pole behavior can be applied in regions of phase space corresponding to observable jet structures is extremely limited. In fact, the perturbative widths for quark jets need not always be narrower than those for gluon jets. Distributions in various jet variables are presented. We find that the three-jet signal in hadronic processes is typically 2 to 4 times larger than in e^+e^- annihilation.

24885 Interaction of massless fermions with instantons. Lee, C. (Michigan Univ., Ann Arbor (USA). Dept. of Physics); Bardeen, W.A. (Fermi National Accelerator Lab., Batavia, IL (USA)). *Nucl. Phys., B;* **153**: No. 1-2, 210-236(1979).

A systematic method is developed of calculating the massless fermion propagation function and fermion-induced effective action in the background gauge field of an arbitrary number of widely separated instantons and anti-instantons. The results exhibit a strongly non-local nature of instanton interactions with massless fermions. Using these results, it is also demonstrated that the ordinary perturbation theory vacuum is not allowed in QCD with massless fermions, since the cluster decomposition for certain correlation functions is violated due to widely separated instanton-anti-instanton bound states. The underlying mechanism is identical to that in the Schwinger model.

SCATTERING THEORY

REFER ALSO TO CITATION(S) 24945

PHYSICS RESEARCH

NUCLEAR PHYSICS

24886 (CONF-791243—1) **ENSDF: its structure, contents, and use in applied research.** Martin, M.J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 10p. NTIS, PC A02/MF A01.

From Japanese Nuclear Data Committee nuclear data workshop; Tokai-mura Ibaraki-ken, Japan (10 Dec 1979).

A computer-based system for obtaining the energies and intensities of both nuclear and subsequent atomic radiations from radioactive nuclides in a format suitable for direct use by researchers in medical practice or research, health physics, industry, nuclear power, and environmental impact studies is discussed. The Evaluated Nuclear Structure Data File (ENSDF) consists of a set of evaluated data sets for each mass chain, including adopted level and decay schemes for each nuclide in that mass chain, and is prepared by the Nuclear Data Project at ORNL. The contents, organization, and status of ENSDF are described, along with its search and retrieval capabilities; both tabular listings and graphical displays may be produced. 3 figures. (RWR)

24887 (DOE/ER/10494—1) **Radioactive decay studies at TRISTAN II. Progress report, July 1, 1979-March 31, 1980.** Walters, W.B. (Maryland Univ., College Park (USA). Dept. of Chemistry). 1980. Contract AS05-79ER10494. 8p. NTIS, PC A02/MF A01.

Research during the period July 1, 1979 to March 31, 1980 is sketched. As TRISTAN II is not yet operational, only preparations for work at that facility are described. 1 figure. (RWR)

EXPERIMENTAL TECHNIQUES

REFER ALSO TO CITATION(S) 24930

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

24888 Comparison of analyzing powers and polarizations for the charge symmetric reactions ^{2}H(d,p)^{3}H and ^{2}H(d,n)^{3}He. Bevelacqua, J.J. (Planning Division, United States Department of Energy, P. O. Box E, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **21**: No. 6, 2685-2686(Jun 1980).

Analyzing powers and polarizations for the ^{2}H(d,n) and ^{2}H(d,p) charge symmetric reactions were calculated in a $4\hbar\omega$ model space within the framework of the generalized R-matrix methodology of Lane and Robson. The calculated differences are approximately an order of magnitude smaller than those quoted by Dries et al.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

24889 (π,p) absorption in /sup 6,7/Li at 75 and 175 MeV. Kaellne, J.; Davis, J.; Gugelot, P.C.; McCarthy, J.S.; Smith, G.R.; Boudrie, R.L.; Hoeistad, B.; Morris, C.L. (Department of Physics, University of Virginia, Charlottesville, Virginia 22901). *Phys. Rev., C;* **21**: No. 6, 2681-2684(Jun 1980).

Differential cross sections are reported for (π^+,p) reactions to discrete final states over the range θ=20—95 (116^0) and for the inclusive (π^{+-},p) reactions in ^{6}Li at θ=20^0 to the continuum. The continuum cross sections indicate the predominance of the two-nucleon pion absorption mechanism where (π^-,p) shows the importance of multiple (charge-exchange) scattering. The combined use of the exclusive and inclusive cross sections is discussed.

NUCLEAR REACTIONS AND SCATTERING

24890 (LA—8087) **Low-energy nuclear fusion data and their relation to magnetic and laser fusion.** Jarmie, N. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 15p. NTIS, PC A02/MF A01.

The accuracy of the basic fusion data for the T(d,n)^{4}He, ^{3}He(d,p)^{4}He, T(t,2n)^{4}He, D(d,n)^{3}He, and D(d,p)T reactions was investigated in the 10- to 100-keV bombarding energy region, and the effects of inaccuracies on the design of fusion reactors were assessed. The data base for these reactions [particularly, the most critical T(d,n)^{4}He reaction] rests on 25-year-old experiments the

accuracy (often assumed to be +- 5%) of which has rarely been questioned: yet, in all except the d + d reactions, there are significant differences among data sets. The errors in the basic data sets may be considerably larger than previously expected, and the effect on design calculations should be significant. Much of the trouble apparently lies in the accuracy of the energy measurements, which are difficult at low energies. Systematic errors of up to 50% are possible in the reactivity values of the present T(d,n)^{4}He data base. The errors in the reactivity will propagate proportionately into the errors in fusion probabilities in reactor calculations. ^{3}He(d,p)^{4}He reaction cross sections could be in error by as much as 50% in the low-energy region. The D(d,n)^{3}He and D(d,p)T cross sections appear to be well known and consistent. The T(t,2n)^{4}He cross section is poorly known and may be subject to large systematic errors. Improved absolute measurements for all the reactions in the low bombarding energy region (10 to 100 keV) are needed, but until they are done, the data sets should be left as they are [except for T(t,2n)^{4}He data, which could be lowered by about 50%]. The apparent uncertainties of these data sets should be kept in mind. 14 figures.

24891 **Proton-deuteron elastic scattering at 800 MeV.** Winkelmann, E.; Bevington, P.R.; McNaughton, M.W.; Willard, H.B.; Cverna, F.H.; Chamberlin, E.P.; King, N.S.P. (copyright-signase Western Reserve University, Cleveland, Ohio 44106). *Phys. Rev., C;* **21**: No. 6, 2535-2541(Jun 1980).

Differential cross sections and polarization analyzing powers for proton-deuteron elastic scattering have been measured at 800 MeV incident proton kinetic energy over the range of center-of-mass angles from 14.1° to 153.6°. The differential cross sections are described by the Glauber theory of impulse approximation at forward angles (-t<0.5) and exhibit the exponential dependence on cosθ/sub c.m./ typical for these energies at backward angles (cosθ/sub c.m./<-0.5). The analyzing power shows considerable structure with strong positive peaks at forward and backward angles and a sharp dip at t=-0.4 typical at intermediate energies. There is no evidence for correspondence of the angular dependence of the analyzing power with that for the pp → dπ^+ reaction. At large momentum transfer the data favor calculations based on multiple scattering with a modified deuteron form factor rather than N* exchange.

24892 **Vector analyzing power in the elastic scattering of ^{6}Li(pol) by ^{4}He.** Egelhof, P.; Barrette, J.; Braun-Munzinger, P.; Dreves, W.; Gelbke, C.K.; Kassen, D.; Steffens, E.; Weiss, W.; Fick, D. (Max-Planck-Institut fuer Kernphysik, Heidelberg (Germany, F.R.)). *Phys. Lett., B;* **84**: No. 2, 176-177(18 Jun 1979).

The elastic scattering of vector polarized ^{6}Li by ^{4}He has been investigated in the energy range of 15.1 to 22.7 MeV. The observed large analyzing powers indicate a strong spin-orbit potential for the ^{6}Li-^{4}He interaction. Optical model calculations using a simple L x S-potential without exchange do not reproduce the data.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 24946, 24947

24893 **Interpretation of quasielastic pion scattering coincidence experiments.** Sternheim, M.M.; Silbar, R.R. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01003). *Phys. Rev., C;* **21**: No. 5, 1974-1978(May 1980).

The energy dependence of the np charge exchange cross section, the angular dependence of the free π^{+-}p cross section ratio, and nucleon "absorption" due to quasielastic scattering are significant in predicting (π^{+-},π^{+-}N) ratios. When these effects are taken into account, recent (π,πN) coincidence data can be understood in the impulse approximation picture, with the recoil nucleon subject to charge exchange on leaving the nucleus.

24894 **^{12}C+^{12}C intermediate structures correlated among elastic and reaction channels.** Cosman, E.R.; Ledoux, R.; Lazzarini, A.J. (Department of Physics and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). EY-76-C-02-3069. *Phys. Rev., C;* **21**: No. 5, 2111-2114(May 1980).

Prominent intermediate structure correlations are suggested between ^{12}C+^{12}C elastic and reaction channel excitation functions over a wide range of energies above the Coulomb barrier. The associated resonant states in ^{24}Mg would have large partial widths to elastic, inelastic, and α+^{20}Ne* channels.

24895 **Coherence angle in heavy-ion reactions.** Braun-Munzinger, P.; Barrette, J. (Department of Physics, State University of New York, Stony Brook, New York 11794). DE-AC02-76-CH00016. *Phys. Rev. Lett.;* **44**: No. 11, 719-722(17 Mar 1980).

The angular cross-correlation function of cross-section fluctuations in heavy-ion reactions is investigated. It is demonstrated that in general the coherence angle is much larger than commonly assumed. Consequences for the identification of heavy-ion resonances are discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 24889, 24897

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 24889, 24933

24896 **(COO—3244-72) Pion absorption processes.** Doss, K.G.R. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Physics). Apr 1980. Contract AC02-76ER03244. 112p. NTIS, PC A06/MF A01.

Proton and deuteron production from low-energy pion absorption in light nuclei leading to discrete and continuum states were measured. The LEP beam line at LAMPF was used with a stack of 8 intrinsic germanium crystals. The proton energy spectra are in general characterized by a broad bump at an energy approximately corresponding to π^+d → pp reaction kinematics, suggestive of pion absorption on 2 nucleons. The energy-integrated cross-section for production of deuterons has an angular distribution similar to that for production of protons. The dependence of the total pion absorption cross-section on A is explained using a semi-classical model for pion transport in nuclei. The (π^+,p) as well as (π^+,d) reactions generally favor transitions involving larger angular momentum transfer to the residual nucleus when states of similar nuclear structure are considered. The low-energy excitation spectra from the (π^+,p) reaction are similar to the spectra from (p,d) reaction on ^{12}C and ^{13}C. However, a calculation of the (π^-,p) cross-section using the measured (p,d) reaction with the formulation of Wilkin to relate the two reactions is in moderate disagreement with the measured (π^+,p) cross-sections. The excitation spectra from the (π^+,p) reaction indicte the importance of two-step processes for the reaction. The (π^+,d) reaction leading to the ground state of — residual nucleus has been seen for ^{7}Li, ^{12}C, and ^{13}C targets. The measured cross section for the ^{12}C(π^+,d)^{10}C reaction to the 2$^+$ state is much higher than that for the ground state. For the case of ^{16}O, no counts were seen for excitation energy of < 10 MeV, at a sensitivity of ~ 100 nb/sr count. These features indicate a possible failure of the model of Betz and Kerman for the (π^+,d) reaction. The ^{13}C target has the largest cross section (~ 2 μb/sr at 35 degrees) among all the nuclei studied. 32 figures, 11 tables.

24897 **Photoneutron studies of E1, M1, and E2 excitations in ^{13}C.** Holt, R.J.; Laszewski, R.M.; Jackson, H.E.; Monahan, J.E.; Specht, J.R. (Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *Phys. Rev., C;* **21**: No. 5, 1699-1704(May 1980).

The angular distribution for the ^{13}C(γ,n$_0$)^{12}C reaction was observed in the energy region 6.5 to 9.3 MeV and at angles of 90° and 135°. The photoneutron measurements were analyzed in terms of a multilevel R-matrix formalism. The ^{12}C(n,n)^{12}C reaction channel was explicitly included in this analysis. The effects of potential capture were directly observed in the photoneutron spectra. The ground-state radiative widths for resonances in this energy region were deduced from the R-matrix interpretation of the results. The ground-state transition probabilities for E1 excitations at 7.69 and 8.19 MeV were found to be in good agreement with the predictions of the weak-coupling model.

24898 **Backward angle cross sections for ^{27}Al+^{16}O reaction products.** Shapira, D.; Ford, J.L.C. Jr.; Gomez del Campo, J.; Stelson, P.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **21**: No. 5, 1824-1827(May 1980).

Reactions induced by bombarding a ^{16}O gas target with ^{27}Al ions were studied. Evaporation residues as well as target-like recoils were measured over a wide range of Q values. The yield of particles with 6< or =Z< or =9 was found to be forward peaked in the laboratory frame. These target-like particles emerge with center-of-mass kinetic energies that, on the average, are independent of the reaction angle. Their combined cross section has a 1/sinθ/sub c.m./ angular dependence. If this cross section is assumed to be symmetric about 90° (c.m.) the integrated cross section is about 10% of the measured evaporation residue cross section at a center-of-mass energy of 54 MeV.

24899 **Nuclear disintegration of some complex nuclei by 60-MeV muons.** Orth, C.J.; Knight, J.D.; Wolfsberg, K.; Johnson, M.W. (Los

Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **21**: No. 5, 1967-1973(May 1980).

Cross sections for muodisintegration reactions (μ^{+-},μ^{+-}xN) at T/sub μ/=60 MeV on eight nuclei from ^{12}C to ^{203}Tl have been measured by activation techniques. The cross sections, like those for comparable electron reactions, increase with target mass number. An additional measurement with 30-MeV μ^+ on ^{12}C shows a positive energy dependence. The observation that $\sigma(\mu^+,\mu^+ xn)<\sigma(\mu^-,\mu^- xn)$ for heavy nuclei implies the presence of Coulomb distortion of the muon trajectories. Calculations employing the virtual photon method in the plane-wave Born approximation, together with reported photonuclear cross sections, give good agreement with the $^{12}C(\mu,\mu'n)^{11}C$results, but not with those for higher-Z nuclei.

24900 $^{12}C(^{13}C,\alpha)^{21}Ne$ reaction. High-spin states, resonances and coherence widths. Cordell, K.R.; Thornton, S.T.; Dennis, L.C.; Lookadoo, P.G.; Schweizer, T.C. (Virginia Univ., Charlottesville (USA). Dept. of Physics); Ford, J.L.C. Jr.; Campo, J.G. Del; Shapira, D. (Oak Ridge National Lab., TN (USA)). *Nucl. Phys., A;* **323**: No. 1, 147-160(2 Jul 1979).

Excitation functions were measured for states of ^{21}Ne populated by the $^{12}C(^{13}C,\alpha)$ reaction over the bombarding energy range E/sub lab/ = 18.2-32.0 MeV (18.4-27.0 MeV) at theta/sub lab/ = 7°(25°) in 200 keV steps, and average coherence widths of states and the moment of inertia of the compound nucleus ^{25}Mg were obtained from these excitation functions. A statistical analysis of these data was performed. Angular distributions for states in ^{21}Ne to 10 MeV in excitation energy were measured at theta/sub lab/ = 7°, 18°, 28° and 43° at bombarding energies from 29.0 to 31.0 MeV in 400 keV steps. These data along with Hauser-Feshbach predictions allow the authors to suggest spins for some states as well as to suggest possible candidates for rotational bands in ^{21}Ne.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 24894, 24902

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 24893

24901 (CONF-7910148—1) **Excitation of giant resonances via charge exchange reactions.** Goodman, C.D. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 14p. Dep. NTIS, PC A02/MF A01.

From Giant multipole resonance topical conference; Oak Ridge, TN, USA (15 Oct 1979).

Charge-exchange reactions can be useful for identifying isovector resonances. At present the most promising use of charge-exchange reactions with respect to giant resonances is to locate and study Gamow-Teller (GT) resonances. Detailed comparisons between GT and M1 strengths can yield further structure information. 7 figures.

24902 Neutron total cross section of sulfur: Single level to multilevel to optical model. Johnson, C.H.; Winters, R.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **21**: No. 6, 2190-2198(Jun 1980).

This paper is a further analysis of the high resolution total cross section of sulfur for 25—1100 keV neutrons that previously were measured by Halperin, Johnson, Winters, and Macklin and evaluated by single-level analysis. The usual procedure in reporting the results of high resolution neutron cross sections has been to present the data and resonance parameters with corresponding neutron strength functions resulting from some type of R-matrix analysis. Often the important nonresonant phase shifts are not reported. In this paper, making use of both strength functions and phase shifts, we extend the analysis to include an average nuclear potential (a spherical optical model). An optical model analysis not only facilitates comparison with a broad spectrum of other nucleon-nucleus experiments, but also may provide an incentive for microstructure calculations. Six average empirical functions, two each for s/sub 1/2/, p/sub 1/2/, and p/sub 3/2/ partial waves, are derived from the R-matrix analysis. From these we deduce optical model parameters, the real and imaginary well depths for s- and p-wave neutrons, and the spin-orbit well depth for p waves. The resulting real well is deeper for p waves than for s waves and for averages over partial waves at higher energies. The depth of the imaginary wells are about half those deduced at higher energies. An interesting feature of the analysis is that the multilevel curve including interference effects is produced from single-level parameters including the phase shifts.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 24900, 24904, 24905, 24907

MOMENTS AND SPIN

REFER ALSO TO CITATION(S) 24900

NUCLEAR REACTIONS AND SCATTERING

24903 Dominance of strong absorption in $^{9}Be+^{28}Si$ elastic scattering. Zisman, M.S.; Cramer, J.G.; Goldberg, D.A.; Watson, J.W.; DeVries, R.M. (Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Rev., C;* **21**: No. 6, 2398-2416(Jun 1980).

The elastic scattering of $^{9}Be+^{28}Si$ has been measured at laboratory energies of 121.0 and 201.6 MeV. These data have been combined with existing lower energy $^{9}Be+^{28}Si$ data in order to carry out a global optical model analysis. Calculations employing Woods-Saxon potentials yield good fits to the data without requiring explicitly energy-dependent parameters. In contrast, using a proximity form for the real potential requires an explicitly energy-dependent Woods-Saxon imaginary potential in order to achieve comparable quality fits. Notch perturbation calculations have been utilized to locate the radial region of the potential to which the scattering is sensitive. At all energies the imaginary potential is stronger than the real potential at the radius of maximum sensitivity. This dominance of the absorptive potential greatly limits the amount of information which can be gained about the real potential. Comparison of the $^{9}Be+^{28}Si$ system with other light heavy ion systems such as $^{6}Li+^{28}Si$, $^{12}C+^{28}Si$, and $^{16}O+^{28}Si$ suggests that the weak binding of ^{9}Be may be responsible for the strong absorption in this case.

24904 $^{24}Mg(^{16}O,^{12}C)^{28}Si$ and $^{24}Mg(^{16}O,^{16}O)^{24}Mg$ reactions at backward angles. Paul, M.; Sanders, S.J.; Geesaman, D.F.; Henning, W.; Kovar, D.G.; Olmer, C.; Schiffer, J.P.; Barrette, J.; LeVine, M.J. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **21**: No. 5, 1802-1809(May 1980).

Excitation functions of the $^{24}Mg(^{16}O,^{12}C)^{28}Si$ and $^{24}Mg(^{16}O,^{16}O)^{24}Mg$ reactions to the ground states and first-excited 2^+ states in ^{28}Si and ^{24}Mg have been measured at θ/sub c.m./=180° over the energy range 24< or =E/sub c.m./< or =40 MeV, where the $^{24}Mg(^{16}O,^{12}C)^{28}Si$ reaction is known to exhibit a strong resonant behavior at forward angles. The four measured excitation functions show prominent structures, about 1 MeV wide, strongly correlated in the elastic and inelastic channels. Angular distributions in the range 110°< or =θ/sub c.m./< or =180° were measured at E/sub c.m./=27.8, 30.8, and 36.2 MeV. At 27.8 and 36.2 MeV, where prominent peaks exist in the ($^{16}O,^{12}C$) backward-angle excitation function, the angular distributions of the transfer to the 0^+ ground state are strongly rising toward 180° and have an oscillatory shape. The partial waves L20,22and 26, respectively, are predominant at these two energies. At 30.8 MeV the data indicate the interference between odd and even partial waves.

24905 Resonant behavior of the $^{24}Mg(^{16}O,^{12}C)^{28}Si$ reaction. Sanders, S.J.; Paul, M.; Cseh, J.; Geesaman, D.F.; Henning, W.; Kovar, D.G.; Kozub, R.; Olmer, C.; Schiffer, J.P. (Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *Phys. Rev., C;* **21**: No. 5, 1810-1818(May 1980).

The $^{24}Mg(^{16}O,^{12}C)^{28}Si$ reaction has been studied over the energy range 26.3<E/sub c.m./<32.4 MeV. Angular distributions with 4.5°< or =θ/sub c.m./< or =50° were measured at nine different energies in this range and an excitation function was measured over a wider range at θ/sub c.m./≅90°. The results of the present measurements, together with previously measured excitation functions at 0° and 180°, are analyzed within the framework of two resonances, at 27.6 and 30.8 MeV, added to a direct reaction background. Probable spin assignments for the two resonances are J=20 (27.6 MeV) and J=23 (30.8 MeV).

24906 Complete fusion of $^{15}N+^{27}Al$. Prosser, F.W. Jr.; Racca, R.A.; Daneshvar, K.; Geesaman, D.F.; Henning, W.; Kovar, D.G.; Rehm, K.E.; Tabor, S.L. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **21**: No. 5, 1819-1823(May 1980).

The total fusion cross section for the system $^{15}N+^{27}Al$ has been measured over an energy range 27 MeV< or =E/sub lab/< or =70 MeV by detection of the fusion-evaporation residues. In addition elastic scattering was measured at six energies and fitted by optical model calculations. The fusion cross section for the system saturates at 1150 +- 50 mb. The data can be well described by the model of Glas and Mosel, using a reasonable set of parameters. The model of Horn and Ferguson also describes the data well if an appropriate charge radius is used. Comparison is made between these results and the fusion cross sections for $^{16}O+^{26}Mg$ and $^{18}O+^{24}Mg$, which lead to the same compound nucleus. The results for

$^{15}N+^{27}Al$ are quite similar to those for $^{18}O+^{24}Mg$, and the differences between the fusion cross sections for these two systems and those for $^{16}O+^{26}Mg$ may be evidence for an entrance channel effect.

24907 Complete fusion of ^{12}C with ^{20}Ne. Tserruya, I.; Barrette, J.; Kubono, S.; Braun-Munzinger, P.; Gai, M.; Uhlhorn, C.D. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **21**: No. 5, 1864-1869(May 1980).

Total fusion cross sections σ/sub F/ have been measured for $^{12}C+^{20}Ne$ in the energy range $24<E/sub\ c.m./<42$ MeV using the ΔE-E technique. The excitation function of σ/sub F/ shows only two structures at E/sub c.m./=29 and 38 MeV which seem of different origin than those observed in the $^{16}O+^{16}O$ system. The saturation value of the measured fusion cross section agrees with that obtained for other systems with nucleons in the s-d shell.

24908 90° excitation functions for elastic scattering of $^{28}Si+^{16}O$ and $^{28}Si+^{12}C$. Kubono, S.; Bond, P.D.; Horn, D.; Thorn, C.E. (Brookhaven National Lab., Upton, NY (USA)). *Phys. Lett., B;* **84**: No. 4, 408-410(16 Jul 1979).

The gross structures in the excitation functions for elastic scattering of $^{28}Si+^{16}O$ and $^{28}Si+^{12}C$, measured at 90°, where only even partial waves contribute, are found to be anti-correlated with those at 180°. Excitation functions at both angles, including the enhanced gross structure at 180°, can be reproduced by calculations using a potential which attracts odd partial waves more than even partial waves.

24909 Resonances in ^{36}Ar via the $^{24}Mg(^{12}C, \alpha)^{32}S$ reaction. Cindro, N.; Moses, J.D.; Stein, N.; Cates, M.; Drake, D.M.; Hanson, D.L.; Sunier, J.W. (Los Alamos Scientific Lab., NM (USA)). *Phys. Lett., B;* **84**: No. 1, 55-58(4 Jun 1979).

Measurements of the $^{24}Mg(^{12}C, \alpha)^{32}S$ reaction at theta/sub lab/ = 5° between E/sub lab/ = 27.5 and 35.5 MeV show resonance structure in the excitation functions for the ground and first excited states. Ground state angular distributions at five incident energies can be fit by P/sub J/^{2}(cos theta) functions with J-values ranging from 10 to 14, which are consistent with the entrance channel grazing angular momenta. The data are discussed within the contexts of (1) Ericson fluctuations and (2) a rotational-like band of resonances.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 24901

24910 Decay of deformed and superdeformed nuclei formed in heavy ion reactions. Blann, M. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* **21**: No. 5, 1770-1782(May 1980).

The importance of considering the deformation of nuclei at high angular momenta in computing transmission coefficients for their decay is the major topic of this work. Deformations based on the rotating liquid drop model were used to generate transmission coefficients versus compound nucleus angular momentum. The results were then used in a Hauser-Feshbach code which included fission competition to assess the ultimate importance of deformation modified transmission coefficients. It was found that for a broad range of prolate nuclei (superdeformed) the course of deexcitation predicted changes totally from predominant fission to predominant α decay because of a new mechanism called α-decay amplification. The phase space relationships responsible for this new mechanism are presented. It is shown that this predicted new decay mode of superdeformed nuclei is consistent with a large body of existing experimental results, though more explicit experiments must be completed to confirm the new mechanism.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 24911

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 24899

24911 800-MeV inelastic proton scattering from ^{40}Ca, ^{48}Ca, and ^{54}Fe. Adams, G.S.; Bauer, T.S.; Igo, G.; Pauletta, G.; Whitten, C.A. Jr.; Wriekat, A.; Hoffmann, G.W.; Smith, G.R.; Gazzaly, M. (Physics Department, University of California, Los Angeles, California 90024). *Phys. Rev., C;* **21**: No. 6, 2485-2495(Jun 1980).

Differential cross sections have been measured over a wide range of angles for the well resolved and/or strongly excited peaks in the inelastic proton spectra from ^{40}Ca, ^{48}Ca, and ^{54}Fe targets. Inelastic analyzing powers were also measured for the ^{54}Fe transitions. Microscopic distorted-wave impulse approximation analyses of the 2^+_1 transitions in ^{48}Ca and ^{54}Fe yield values for the ratio B(N2)/B(E2). Collective-model distorted-wave Born-approximation calculations for the high-spin levels at 8.85 and 9.24 MeV in ^{40}Ca suggest spin and parity assignments of 6^+ and 5^-, respectively.

24912 Evidence for an E2 resonance observed by radiative capture of fast neutrons by ^{40}Ca. Roberson, N.R.; Potokar, M.; Tilley, D.R.; Wender, S.A.; Weller, H.R. (Triangle Universities Nuclear Lab., Durham, NC). pp 731-733 of Neutron capture gamma-ray spectroscopy. Chrien, R.E.; Kane, W.R. (eds.). New York, NY; Plenum Publishing Corp. (1979).

Cross sections were measured for the $^{40}Ca(n,\gamma_0)^{41}Ca$ reaction at 7 angles in 1 MeV steps and at 90° in 200 keV steps from 6 to 13 MeV. The extracted a_2 coefficients and the fore-aft asymmetry are in good agreement with a direct-semidirect model calculation if the isoscalar giant quadrupole resonance is included. 2 figures.

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 24910

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

RADIOACTIVE DECAY

24913 Level properties of $^{85}_{37}Rb_{48}$ from the decay of the ^{85}Kr and ^{85}Sr isomers and the cluster-vibration model. Meyer, R.A.; Fontanilla, J.E.; Smith, N.L.; Smith, C.F.; Ragaini, R.C.; Paar, V. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* **21**: No. 6, 2590-2599(Jun 1980).

We have investigated the decay of ^{85}Kr/sup m/, ^{85}Kr/sup g/, ^{85}Sr/sup m/, and ^{85}Sr/sup g/ using Ge(Li) spectroscopy and intrinsic Ge Compton-suppression spectroscopy techniques. We observe levels at (J/sup π/ in parentheses) g.s. ($5/2^-$), 151.18 ($3/2^-$), 281.01 ($1/2^-$), 513.998 ($9/2^+$), 731.79 ($3/2^-$), 868.05 ($7/2^-$), and 921 ($1/2^-$,$3/2^-$) keV. Our data suggest that the ~880 keV level observed in (t,α) and (^{3}He,d) reactions is the known 868-keV level. The Q/sub EC/ value for the ^{85}Sr/sup m/ decay is calculated to be 1323 +- 20 keV from our EC/β^+ intensity data. We use the cluster-vibration model to calculate the ^{85}Rb level structure and electromagnetic decay properties. For the latter, we discuss the role of the M1 tensor operator.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 24913

NUCLEAR REACTIONS AND SCATTERING

24914 Products of stopped-pion interactions with Cu and Ta. Orth, C.J.; Daniels, W.R.; Dropesky, B.J.; Williams, R.A.; Giesler, G.C.; Ginocchio, J.N. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **21**: No. 6, 2524-2534(Jun 1980).

Yields of radioactive products from the interactions of stopped π^- with Cu and Ta have been measured. Absolute yields of products ranging down to 10^{-5} per stop were determined. The experimental yields are compared with yields calculated with a model that was developed in this work for the stopped-π^- interaction. The calculations give excellent agreement with measured total mass yields for Ta, but some discrepancies exist for the independent yields of Hf, Er, and Tm isotopes; in the case of Cu, most independent yields, except for Co and Sc, are in good agreement. Measurements were also made with both stopped π^- and 20-MeV π^+ on Cu and Fe to determine the shift in the centroids of the isotopic yields with pion charge.

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 24910

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 24901, 24910

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 24917

MOMENTS AND SPIN

24915 Isovector deformation parameters and core polarization. Finlay, R.W.; Rapaport, J. (Ohio Univ., Athens (USA). Dept. of Physics); Brown, V.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.); Madsen, V.A. (Oregon State Univ., Corvallis (USA). Dept. of Physics); Comfort, J.R. (Pittsburgh Univ., PA (USA). Dept. of Physics). *Phys. Lett., B;* **84**: No. 2, 169-172(18 Jun 1979).

Analysis of measurements of elastic and inelastic neutron scattering cross sections on $^{116\ 118\ 120\ 122\ 124}$Sn is reported. The isovector and isoscalar quadrupole deformation parameters β_1 and β_0 are obtained in a set of isotopes from a comparison with published parameters from (p,p') measurements. The relation $\beta_1 > \beta_0$ anticipated from shell model arguments is verified, and its value of about 2 is roughly the same magnitude predicted by the schematic model of core polarization by valence neutrons.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 24923

24916 Fusion of ^{16}O+/sup 148,150,152,154/Sm at sub-barrier energies. Stokstad, R.G.; Eisen, Y.; Kaplanis, S.; Pelte, D.; Smilansky, U.; Tserruya, I. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **21**: No. 6, 2427-2435(Jun 1980).

Measurements of the cross section for fusion of ^{16}O with /sup 148,150,152,154/Sm have been made in the range 60< or =EO< or =75 MeV. Evaporation residues trapped in a carbon catcher foil were observed off line by means of the K x rays emitted by radioactive Yb nuclei and their daughters. Absolute cross sections varying in magnitude from 0.1 to 400 mb were determined with an uncertainty of +- 10%. The cross sections for individual x-n channels were also determined. At high energies, the fusion cross sections for all isotopes are similar, whereas at lower bombarding energies the cross sections for the more deformed targets are larger than those for the spherical targets.

24917 Search for nuclear structure dependence of analyzing powers for the (t,p) reaction in medium mass nuclei. Brown, R.E.; Cizewski, J.A.; Sunier, J.W.; Flynn, E.R.; Alford, P.; Sugarbaker, E.; Ardouin, D. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **21**: No. 6, 2663-2665(Jun 1980).

Recent measurements of the (p,t) reaction on targets in the mass range 106 < or = A < or = 128 have shown a change in the sign of the analyzing power at forward angles for transitions to the lowest 2^+ states. The (t,p) reaction has been used in a similar search for corresponding effects on targets of ^{96}Mo, ^{106}Pd, and ^{126}Te. In contrast to the (p,t) results, the analyzing power for L=2 transitions in the (t,p) measurements does not show a sign change and the data are fitted with standard distorted-wave Born-approximation calculations.

24918 (^{3}He, n) reaction on tellurium isotopes. Alford, W.P.; Anderson, R.E.; Batay-Csorba, P.A.; Emigh, R.A.; Lind, D.A.; Smith, P.A.; Zafiratos, C.D. (Colorado Univ., Boulder (USA). Nuclear Physics Lab.). *Nucl. Phys., A;* **323**: No. 2-3, 339-348(1979).

The $^{122\ 124\ 125\ 126\ 128\ 130}$Te(^{3}He, n) reactions have been studied at an incident energy of 25.4 MeV using the University of Colorado 9m neutron time-of-flight facility. Angular distributions of neutrons have been measured for all targets over the angular range 0°-22°. In addition to the ground-state transitions relatively strong L = 0 transitions to excited levels in the region of 2.0 MeV are observed in all residual nuclei. The experimental results are compared to zero-range DWBA predictions. Pairing model calculations are able to account for the strongly excited low-lying J/sup π/ = 0^+ states observed.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 24949

24919 Is there evidence for rotation along the axis of symmetry in transitional nuclei. Peker, L.K. (Brookhaven National Lab., Upton, NY (USA)); Hamilton, J.H. *J. Phys., G (London);* **5**: No. 11, L203-L205(Nov 1979).

An approximate I(I + 1) behaviour of the yrast level energies in transitional nuclei corresponding to rotation along the axis of symmetry is expected when angular momentum is generated by aligning that of the individual nucleons along the symmetry axis. From an analysis of the yrast energies for states with I = 14 to 37 in ^{152}Dy, an I(I + 1) behaviour was reported and interpreted as the first experimental demonstration of rotation along the axis of symmetry. It is shown that such a significance for the experimental data is not unfortunately possible.

24920 Flow patterns for collective rotations in heavy nuclei. Kunz, J.; Mosel, U. (Washington Univ., Seattle (USA). Dept. of Physics). *Nucl. Phys., A;* **323**: No. 2-3, 271-284(1979).

Current and velocity fields for collective rotations are calculated from cranked BCS correlated wave functions for even-even rare earth nuclei. The single-particle Hamiltonian used is that of the Nilsson model. The velocity fields obtained do not yield a spherical inert core, in contrast to the two-fluid model. It is shown that the flow pattern can be represented quite accurately by a superposition of irrotational and rigid flow. The strength of the former can reach up to 60% - depending on the specific nucleus - in the case without pairing and is usually about 80% with pairing. Finally several forms for the collective rotational energy are compared. It is found that the classical expression grossly underestimates the correct energies.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 24815

24921 Decay of ^{180}Re: Search for octupole states in ^{180}W. Mann, L.G.; Carlson, J.B.; Lanier, R.G.; Struble, G.L.; Buckley, W.M.; Sheline, R.K.; Singh, Z. (Nuclear Chemistry Division, Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* **21**: No. 6, 2547-2555(Jun 1980).

Study of the decay of 2.45-min ^{180}Re leads to the observation of about 90 γ rays and a number of new levels in ^{180}W. Spins and parities of many of the levels observed are determined using the logft values of positron population and/or the γ-ray depopulation. The allowed unhindered decay from the ($\pi 5/2^+$[402up-arrow]-$\nu 7/2^-$[514arrow-down])$_1$- ^{180}Re ground state indicates fragmentation of the ($\pi 5/2^+$[402up-arrow]-$\pi 9/2^-$[514up-arrow])$_2$- configuration among a number of 2^- states in ^{180}W. We find tentative observation of the $K=1^-$ and 0^- components of the octupole vibration. This would establish the excitation energy of all four expected octupole components in ^{180}W.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 24921, 24924, 24925, 24930

24922 High-spin properties of ^{164}Er in the multiple band crossing region. Yates, S.W.; Lee, I.Y.; Johnson, N.R.; Eichler, E.; Riedinger, L.L.; Guidry, M.W.; Kahler, A.C.; Cline, D.; Simon, R.S.; Butler, p.A.; Colombani, a.; Stephens, F.S.; Diamond, R.M.; Ronningen, R.M.; Hichwa, R.D.; Hamilton, J.H.; Robinson, E.L. (University of Kentucky, Lexington, Kentucky 40506). *Phys. Rev., C;* **21**: No. 6, 2366-2384(Jun 1980).

High-spin states in ^{164}Er have been studied by using the ^{150}Nd(^{18}O,4nγ) and ^{164}Dy(α,4nγ) reactions and by multiple Coulomb excitation with ^{136}Xe ions. Several positive-parity bands are excited, and two negative-parity bands have been identified. The previously reported backbending behavior of the yrast sequence is demonstrated to result from the intersection of the ground band (seen to spin 22^+) with an even-spin "superband" observed from spins 12^+ to 24^+. The odd-spin yrast superband and the second lowest even-spin superband also have been observed. All the superbands have moments of inertia appreciably larger than the ground band. The observed intersection of these multiple superbands with the γ band produces different backbending behavior and a staggering of the energies of the odd- and even-spin members of the γ band. B(E2) values for transitions below and through the band intersection regions of both the ground band and γ bands have been deduced from multiple Coulomb excitation yields. In addition, lifetimes have been measured for the ground band by the Doppler-broadened line-shape technique. The level energies and B(E2) values are consistent with weak interaction matrix elements ($\simeq$ 45 keV) between the intersecting bands. The B(E2) values of the unperturbed band are found to obey the simple rigid-rotor relationship. The 7^- negative-parity band exhibits a normal rotational sequence, while the 5^- band exhibits a large odd-even staggering and a larger moment of inertia. Two-quasiparticle-plus-rotor model calculations indicate strong rota-

tion alignment and reproduce the observed properties of the high-spin states for both the positive- and negative-parity bands in ^{164}Er.

24923 Single particle nature of the yrast line at high angular momentum in ^{152}Dy. Haas, B.; Andrews, H.R.; Haeusser, O.; Horn, D.; Sharpey-Schafer, J.F.; Taras, P.; Trautmann, W.; Ward, D. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.); Khoo, T.L.; Smither, R.K. (Argonne National Lab., IL (USA)). *Phys. Lett., B;* **84**: No. 2, 178-181(18 Jun 1979).

Linear polarization and Doppler shift recoil-distance decay curves for γ-ray transitions deexciting very high spin yrast states up to spin 36h/2π in ^{152}Dy were measured with a delayed-prompt γ-γ coincidence technique via the reactions ^{122}Sn(^{34}S, 4n) and ^{124}Sn(^{34}S, 4n), at 150 MeV incident beam energy. The deduced experimental transition probabilities are consistent with those obtained for non-rotational nuclei, hence, the yrast angular momentum originates mainly from the alignment of individual particle spins.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 24899, 24914, 24916, 24922, 24929

24924 W(p,t) reactions. I. Even targets. Mortensen, M.H.; Betts, R.R.; Bockelman, C.K. (A. W. Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). EY-76-C-02-3074. *Phys. Rev., C;* **21**: No. 6, 2275-2287(Jun 1980).

Data for two-nucleon transfer reactions on even tungsten nuclei are presented. Several systematic features emerge from the data and are discussed in detail. These include the influence of multistep processes on angular distribution shapes. The systematic behavior of excited 0^+ strengths is shown to arise from two types of excitation, one associated with a subshell gap at N=108, the other being of the pairing isomer type.

24925 W(p,t) reactions. II. Odd target. Mortensen, M.H.; Betts, R.R.; Bockelman, C.K. (A. W. Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). EY-76-C-02-3074. *Phys. Rev., C;* **21**: No. 6, 2288-2292(Jun 1980).

Data for the ^{183}W(p,t)^{181}W reaction are presented. States corresponding to the coupling of the odd neutron to collective excitations of the even core are identified and used to test the microscopic structure of these collective excitations. In particular, the proposed nature of the pairing isomers observed in the neighboring even nuclei is confirmed. Information concerning the previously observed anomalous population of 2^+ states in this mass region is also presented.

24926 Target residues from the reaction of 8 GeV ^{20}Ne with ^{181}Ta and ^{197}Au. Morrissey, D.J.; Loveland, W.; de Saint Simon, M.; Seaborg, G.T. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., C;* **21**: No. 5, 1783-1798(May 1980).

The cross sections for the production of 99 different target fragments from reactions of 8.0 GeV ^{20}Ne with ^{181}Ta and ^{197}Au were measured. The target fragment radioactivities were measured by off-line gamma-ray spectroscopy. Details of the measurement as well as the calculation of the independent isotopic production cross sections and the integrated mass yields are given. Comparisons of these data to previously reported data for proton induced reactions show that the target residue production cross sections scale with the total projectile kinetic energy, not velocity. The total cross section for residue production indicates that some products result from collisions with significant overlap of the central densities of the two nuclei, in contrast to results obtained with low mass targets. Comparisons of the data with a Monte Carlo cascade calculation and an abrasion-ablation calculation verify the importance of ground state correlations of the neutrons and protons on the fragmentation isotopic cross sections.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, THEORETICAL

MASS, ABUNDANCE, AND BINDING ENERGY

24927 (UCRL—84370) **Prediction of heavy element fission barrier features for multiple chance neutron cross-section calculations.** Cusson, R.Y.; Howard, W.M.; Meldner, H.M.; Moeller, P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-48. 9p. (CONF-800551—1). NTIS, PC A02/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

A state-of-the-art calculation of even, odd, and even-odd heavy neutron-rich element fission barriers and neutron binding energies is described. The range 76 ≦ Z ≦ 100, 118 ≦ N ≦ 184 is selected for application to ICF burnup. Some techniques for exploring multidimensional parameter spaces on the computer are discussed. Contour maps of fission barriers and neutron binding energies are shown. 3 figures.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 24893

24928 Exactly central heavy-ion collisions by nuclear hydrodynamics. Tang, H.H.K.; Wong, C. (A. W. Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). EY-76-C-023074;W-7405-ENG-26. *Phys. Rev., C;* **21**: No. 5, 1846-1863(May 1980).

We study the dynamics of heavy-ion collisions using the hydrodynamical description and focus our attention on the head-on collisions which provide the most favorable case for such a description. Angular distributions and energy distributions were obtained for various combinations of projectiles and targets of equal and unequal masses in the energy range from 50 to 400 MeV per projectile nucleon. It is found that regions of high density (the shock regions) are formed during the collisions and that the angular and energy distributions for many of these collisions have prominent features. In the collision of a small projectile with a heavy target, there is the forward angular peak of slow dissociated particles which represent much of the projectile nuclear matter stopped in the larger target nucleus, in addition to the nucleons from the expansions of the shock region. There is the side angular peak corresponding to the sidesplash of the target nuclear matter due to the impact of the projectile. There is also the backward angular peak due to the expansion of the shock region into the backward direction. In the collision of two equal nuclei, there are only the forward angular peak and the side angular peak. The effects of viscosity and thermal conductivity are investigated and found to affect the angular and energy distributions of the reaction products.

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 24927

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 24933

RADIOACTIVE DECAY

24929 New isotope ^{199}Rn and evidence for an isomeric state ^{199}Rn/sup m/. DiRienzo, A.C.; Enge, H.A.; Gazes, S.B.; Salomaa, M.K.; Sperduto, A.; Schier, W.; Wegner, H.E. (Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., C;* **21**: No. 5, 2101-2102(May 1980).

The nuclide ^{199}Rn has been produced in the ^{169}Tm(^{35}Cl,5n)^{199}Rn reaction. The recoiling ^{199}Rn nuclei were separated from the beam at zero degrees by a recoil-separator arrangement utilizing electric and magnetic fields, and detected by their alpha decay signatures in a surface-barrier detector. Two alpha lines were found with energies 6.990 +- 0.015 MeV and 7.060 +- 0.015 MeV. Alpha decay of the known daughter ^{195}Po was also observed.

ENERGY LEVELS AND TRANSITIONS

24930 (CONF-790976—9) **Use of systematics in the interpretation of nuclear structure far from the beta-stable region.** Wood, J.L. (Georgia Inst. of Tech., Atlanta (USA). School of Chemistry). 1979. Contract W-7405-ENG-26. 12p. Dep. NTIS, PC A02/MF A01.

From International symposium on future directions in studies of nuclei far from stability; Nashville, TN, USA (10 Sep 1979).

The use of systematics in the interpretation of nuclear structure far from the beta-stable region is discussed. In particular, a set of rules for the use of systematics is presented together with some experimental criteria that need to be fulfilled for radioactive decay scheme studies in order that all states up to a given spin-parity and energy are located. Illustrative examples are taken from the region 180 < A < 210, with particular emphasis on the odd-mass Au and Hg nuclei. 6 figures.

24931 Investigation of natural-parity high-spin states in ^{208}Pb by (e,e') reactions. Lichtenstadt, J.; Papanicolas, C.N.; Sargent, C.P.; Heisenberg, J.; McCarthy, J.S. (Bates Linear Accelerator Center, Laboratory for Nuclear Science, and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). EY-76-C-02-3069;DE-AS02-79ER10338;DE-AS05-7805861. *Phys. Rev. Lett.;* **44**: No. 13, 858-861(31 Mar 1980).

Natural-parity high-spin states of J/sup π/=12^+ (6.10 MeV) and 10^+ (4.89, 5.07, and 5.92 MeV) were observed and identified via

inelastic electron scattering. Dominant single-particle—hole configurations in these excitations were deduced. The measured cross sections indicate a reduction of the transverse transition amplitude to 65% of the shell-model prediction, and the absence of an effective charge for the neutron.

24932 Level structure of ^{196}Pt. Cizewski, J.A.; Casten, R.F.; Smith, G.J.; Macphail, M.R.; Stelts, M.L.; Kane, W.R. (Brookhaven National Lab., Upton, NY (USA)); Boerner, H.G.; Davidson, W.F. (Institut Max von Laue - Paul Langevin, 38 - Grenoble (France)). *Nucl. Phys., A;* **323**: No. 2-3, 349-391(1979).

The ^{195}Pt(n, γ)^{196}Pt reaction has been investigated with the use of numerous experimental techniques. A level scheme has been established consisting of 58 levels below 2.5 MeV, most of which are assigned J/sup π/ values of 0^+, 1^+, or 2^+. Average resonance capture measurements have led to the identification of all 0^+, 1^+ or 2^+ states below 2.5 MeV and the location of the pairing energy gap at approximately 1.8 MeV. All positive-parity states in ^{196}Pt below the energy gap can be understood in terms of the O(6) limit of the interacting boson approximation (IBA) model. In addition to the positive-parity states, a number of probable negative-parity states have been identified. These states can be understood in terms of a model involving particularly decoupled bands.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 24899, 24931, 24932

24933 Sub-Coulomb transfer reactions on ^{208}Pb with carbon and oxygen projectiles. Franey, M.A. (Minnesota Univ., Minneapolis (USA). School of Physics and Astronomy); Lilley, J.S. (Science Research Council, Daresbury (UK). Daresbury Lab.); Phillips, W.R. (Manchester Univ. (UK). Dept. of Physics). *Nucl. Phys., A;* **324**: No. 1, 193-220(23 Jul 1979).

Single-neutron transfers induced by ^{12} ^{13}C and ^{16} ^{17} ^{18}O projectiles on ^{208}Pb and the ^{12}C(^{17}O,^{16}O)^{13}Creaction have been studied at energies close to the Coulomb carrier. These processes are well described by the distorted-wave Born approximation. Coupled-channels effects are found to be small. Normalization factors have been determined for all projectile and target transitions, and also for the triton-deuteron overlap by comparison with previous measurements of the ^{209}Pb(d,t)^{207}Pb reaction. The root-mean square (rms) radii of single-particle neutron wave functions in ^{208}Pb were calculated using known spectroscopic factors. The distribution of the point neutron excess density in the surface region of ^{208}Pb has been derived and its rms radius determined to be 5.93+-0.13 fm with a local potential model. This is in good agreement with theoretical predictions, but is considerably larger than estimates based on Coulomb energy differences. The phenomena of core polarisation by the odd particles or hole outside ^{208}Pb is discussed using the single-particle orbitals determined in this work.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 24927

24934 Superheavy elements. Nix, J.R. (Los Alamos Scientific Lab., NM (USA)). *S.Afr. J. Phys.;* **1**: No. 3/4, 103-113(1978).

From International conference on dynamical properties of heavy-ion reactions; Johannesburg, South Africa (1 - 3 Aug 1978).

To understand why superheavy elements have not been found and to assess the prospects for their future discovery, we evaluate the predictions that have been made concerning their nuclear stability and possible methods of production. Particular attention is devoted to the dynamics of large-scale nuclear collective motion, which hinders their production in heavy-ion reactions.

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 24927

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

RADIOACTIVE DECAY

24935 Levels of ^{230}Ac and ^{230}Th populated by decay of ^{230}Ra and ^{230}Ac. Gilat, J.; Katcoff, S.; Peker, L.K. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **21**: No. 5, 2041-2047(May 1980).

Decay schemes, based on γ-ray and β-ray spectroscopy, are proposed for 93-min ^{230}Ra and 122-sec ^{230}Ac. Of 48 observed γ transitions following decay of ^{230}Ra, 39 are accommodated among 19 levels in ^{230}Ac. For decay of the ^{230}Ac, 135 γ transitions were observed and 98 are accounted for among 46 levels (22 known previously) in ^{230}Th. The ground state of $^{230}_{89}Ac_{141}$ is assigned I/sup π/=K/sup π/=1^+. A number of levels are discussed in terms of Nilsson orbital assignments. Q-≅0.71 MeV for ^{230}Ra and Q-=2.70 MeV for ^{230}Ac.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 24935

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 24937

24936 (DP-MS—79-106) **Energy dependence of the ^{238}U thermal capture cross section.** Baumann, N.P.; Owais, M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract AC09-76SR00009. 19p. (CONF-800607—34). NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

Integral activation measurements supported the thermal neutron energy dependence of ^{238}U assumed in the ENDF/B-IV evaluation. The activation measurements were conducted in a thermally insulated graphite block at the side of the SP Reactor. The block was thermally heated to temperatures up to 450°C. In addition to heating, gasolinium filters were used to tailor the neutron spectra incident on the foils. The metallic foils consisted of copper and depleted uranium. Copper served as the 1/v reference. Activation ratios of ^{238}U to ^{63}Cu in the tailored spectrum were compared with corresponding ratios in a well thermalized flux at room temperature. The difference in this ratio is strongly dependent on the energy dependence of the ^{238}U cross section. 8 figures, 1 table.

SPONTANEOUS AND INDUCED FISSION

24937 Actinide muonic atom lifetimes deduced from muon-induced fission. Wilcke, W.W.; Johnson, M.W.; Schroeder, W.U.; Hilscher, D.; Birkelund, J.R.; Huizenga, J.R.; Browne, J.C.; Perry, D.G. (Departments of Physics and Chemistry and Nuclear Structure Research Laboratory, University of Rochester, Rochester, New York 14627). *Phys. Rev., C;* **21**: No. 5, 2019-2024(May 1980).

Time distributions of fragments from delayed fission after muon capture have been measured for muonic ^{235}U, ^{238}U, ^{237}Np, ^{239}Pu, and ^{242}Pu. Comparison of these data with previously measured lifetimes using muon decay electrons, neutrons, and γ rays emitted after muon capture indicates that the observed systematic discrepancies are due to atomic muon capture by fission fragments after prompt fission induced by radiation-less muonic transitions. The deduced capture rates are compared with theoretical models, and very good agreement is found with a giant-resonance excitation model.

24938 Fission properties of the heavy actinides. Wilhelmy, J.B.; Britt, H.C.; Hoffman, D.C. (Los Alamos Scientific Lab., NM (USA)). *S.Afr. J. Phys.;* **1**: No. 3/4, 116-117(1978).

From International conference on dynamical properties of heavy-ion reactions; Johannesburg, South Africa (1 - 3 Aug 1978).

Properties of fission products and fission barriers have been obtained for neutron excess isotopes at the limits of conventional production techniques. The spontaneous fission decay of ^{258}Fm and $^{}$ Fm are the first cases to be studied in which symmetric mass division accompanied by high kinetic energy release is the dominant mode of division. The fission barriers show that for N=154 there is a substantial break (of over 1 MeV) from the smooth systematics and that for ^{252}Cf fission transmission resonances are observed. Neither of the properties is predicted by current theories, which suggests that additional theoretical studies should be performed in this region before credence can be given to extrapolated properties of nuclei in the superheavy region.

NUCLEAR THEORY

NUCLEAR STRUCTURE

24939 (LBL—10645) **Phenomena at very high spins.** Stephens, F.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 14p. (CONF-800213—11). NTIS, PC A02/MF A01.

From Band structure and nuclear dynamics conference; New Orleans, LA, USA (28 Feb 1980).

The present talk has three parts: first, a discussion of current ideas about the physics of very high spin states; second, some comments about noncollective behavior up to the highest spins where it is known, ~ 40 h; and finally, a presentation of the newest method for studying collective behavior up to spins of 60 to 70 h. The intention is that the overview presented in the first part will be sufficiently broad to indicate the relationship of the noncollective and collective behavior discussed in the other parts, and to provide some understanding of the compromise in behavior that seems to occur at the very highest spins. 13 figures.

24940 Pseudomagic nuclei. Scharff-Goldhaber, G. (Brookhaven National Lab., Upton, NY (USA)). *J. Phys., G (London);* **5**: No. 11, L207-L211(Nov 1979).

It has been shown previously that, below a critical angular momentum, yrast bands of non-magic nuclei are well described by the two-parameter variable moment of inertia model. Some striking exceptions to this rule are found in nuclei which have the same mass number as doubly magic nuclei but possess either one (or two) proton pairs beyond a magic number and one (or two) neutron hole pairs, or vice versa. Yrast bands in these 'pseudomagic' nuclei resemble those in magic nuclei.

NUCLEAR MATTER

24941 Thermodynamic behavior of non-strange baryonic matter. Garpman, S.I.A.; Glendenning, N.K.; Karant, Y.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nucl. Phys., A;* **322**: No. 2-3, 382-396(1979).

Within the framework of relativistic mean-field theory the authors examine effects of the non-strange baryonic resonances on the nuclear equation of state. Universal coupling constants to a scalar and vector meson field are assumed. Two transcendental equations have to be solved for two unknown parameters, the baryon scalar density and the nucleon chemical potential. The equations are solved numerically using a Newton-Raphson method for two cases: all known non-strange baryon resonances included and, finally, the low-mass baryon resonances and an exponentially growing continuum. The result is compared with those from relativistic ideal gas calculations. In addition, the possibility of forming metastable states, which would provide a stabilizing mechanism for nuclear fireballs, is discussed.

NUCLEAR REACTIONS AND SCATTERING

24942 Wave-function formalisms in the channel coupling array theory of many-body scattering. Levin, F.S. (Physikalisches Institut der Universitaet Bonn, D 5300, Bonn, West Germany). *Phys. Rev., C;* **21**: No. 6, 2199-2210(Jun 1980).

Wave-function formalisms corresponding to different channel coupling array transition operators of many-body scattering theory are derived and discussed. The Kouri-Levin transition operators are seen to be in typical Lippmann-Schwinger form and allow for the introduction of wave-function components in a particularly straightforward way. The Baer-Kouri transition operators are not in the Lippmann-Schwinger form and an alternate procedure is used to derive their corresponding wave-function components. In the three-body case, the Kouri-Levin operators T/sub j/k obtained from the Faddeev-Lovelace choice of channel coupling array are seen to lead to precisely the Faddeev wave-function components. The Baer-Kouri operators are shown to lead to wave-function components obeying inhomogeneous equations. These inhomogeneous equations are used to give an alternate explanation of the nonunitary amplitudes obtained in recent calculations based on approximate forms of the Baer-Kouri operators.

24943 Techniques for heavy-ion coupled-channels calculations. I. Long-range Coulomb coupling. Rhoades-Brown, M.; Macfarlane, M.H.; Pieper, S.C. (Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *Phys. Rev., C;* **21**: No. 6, 2417-2426(Jun 1980).

Direct-reaction calculations for heavy ions require special computational techniques that take advantage of the physical peculiarities of heavy-ion systems. This paper is the first of a series on quantum-mechanical coupled-channels calculations for heavy ions. It deals with the problems posed by the long range of the Coulomb coupling interaction. Our approach is to use the Alder-Pauli factorization whereby the channel wave functions are expressed as products of Coulomb functions and modulating amplitudes. The equations for the modulating amplitudes are used to integrate inwards from infinity to a nuclear matching radius (≃ 20 fm). To adequate accuracy, the equations for the amplitudes can be reduced to first order and solved in first Born approximation. The use of the Born approximation leads to rapid recursion relations for the solutions of the Alder-Pauli equations and hence to a great reduction in computational labor. The resulting coupled-channels Coulomb functions can then be matched in the usual way to solutions of the coupled radial equations in the interior region of r space. Numerical studies demonstrate the reliability of the various techniques introduced.

24944 Techniques for heavy-ion coupled-channels calculations. II. Iterative solution of the coupled radial equations. Rhoades-Brown, M.; Macfarlane, M.H.; Pieper, S.C. (Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *Phys. Rev., C;* **21**: No. 6, 2436-2446(Jun 1980).

This paper, the second in a series on techniques for heavy-ion coupled-channels calculations, compares various iterative methods for the solution of the coupled radial equations in the interior region of configuration space. We consider the Born-Neumann series, sequential iteration, the method of moments, and Austern's modification of the Sasakawa method. The use of Pade approximants is shown to eliminate convergence problems with Born and sequential iteration. We conclude that sequential iteration with Pade acceleration is the most rapidly convergent and most efficient way of carrying out coupled-channels calculations for heavy-ion inelastic scattering; 0.5% accuracy in cross sections can be achieved with three or four iterations in each partial wave.

24945 Phenomenological relativistic quantum mechanics of the NNπ system. Betz, M.; Coester, F. (Argonne National Laboratory, Argonne, Illinois 60439). W-31-109ENG38. *Phys. Rev., C;* **21**: No. 6, 2505-2510(Jun 1980).

The theoretical basis is given for a class of mathematically well defined NNπ models. They are designed to describe nucleon-nucleon scattering, pion-nucleon scattering, pion-deuteron scattering, pion production, and absorption. The elementary degrees of freedom of the models are the nucleon, the Δ isobar, and the pion. The models are relativistic and do not require renormalization.

24946 Description of direct nuclear rearrangement reactions using various coupled channel equations. Greben, J.M.; Levin, F.S. (Brown Univ., Providence, RI (USA). Dept. of Physics). *Nucl. Phys., A;* **325**: No. 1, 145-170(13 Aug 1979).

The standard description of direct rearrangement reactions by means of the distorted wave Born approximation (DWBA) or the coupled reaction channel (CRC) method has provided little insight into the role of rearrangement coupling effects in these reactions. Essential to these calculational schemes is the bound state approximation (BSA), i.e., the replacement of the full wave function by product wave functions corresponding to relevant asymptotic channels. The role of the continuum in rearrangement effects is thus ignored. Many-body scattering theory provides a powerful, mathematically correct tool for assessing the validity of these approximate schemes for improving the treatment of the coupling mechanisms. In this paper one of the many-body scattering theories, the channel coupling array (CCA) theory, is used to study rearrangement coupling effects in the BSA both theoretically and computationally. The results of these calculations are compared with those from the DWBA and the CRC scheme for the transfer reactions $^{16}O(d,p)^{17}O(2s/sub\ 1/2/)$, $^{16}O(\alpha,^3He)^{17}O(2/sub\ 1/2/)$, and $^{19}F(^3Ne,d)^{20}He(O^+)$.

24947 Core polarization effects in inelastic pion-nucleus scattering. Oset, E.; Strottman, D. (Los Alamos Scientific Lab., NM (USA)). *Phys. Lett., B;* **84**: No. 4, 396-400(16 Jul 1979).

Pion-nucleus inelastic processes are analyzed within the framework of Glauber theory, and the possibility of expressing the effects of core polarization by means of a renormalizing constant is explored. Estimates are made of the size of the polarization effects, and the results are used to interpret the recent data of $^{18}O(\pi^{+-},\pi^{+-})^{18}O(2^+)$.

NUCLEAR MOMENTS AND SPIN

REFER ALSO TO CITATION(S) 24864

NUCLEAR MODELS

24948 One-body dissipation and nuclear dynamics. Randrup, J.; Swiatecki, W.J. (NORDITA, Blegdamvej 17, DK-2100 Copenhagen O, Denmark). W-7405-ENG-48. *Ann. Phys. (N.Y.);* **125**: No. 1, 193-226(Mar 1980).

We discuss recent developments in the "one-body" dissipation theory described in Blocki et al. [Ann. Phys. (N.Y.) 113 (1978), 330]. The principal new result is the derivation of the functional form of the dissipation expression (the Rayleigh Dissipation Function) for a finite idealized nucleus with a diffuse surface, in the form of an expression in powers of the dimensionless ratio of the surface diffuseness to the size, R, of the system. The leading term in such an expansion is a surface contribution, of relative order R^2, in the form of the "Wall Formula" of Blocki et al. The nest is a curvature correction of order R. At the next level (R^0) there are two higher order curvature corrections and a correction for the presence of gradients in the normal velocity field specifying the motion of the surface. For simple models of the nuclear surface profile we work out analytically the coefficients in the curvature and velocity-gradi-

ent correction terms. We compare the one-body dissipation theory formulated in this way with recent linear-response and Time-Dependent Hartree-Fock treatments of the nuclear problem. The principal theme that emerges from this study is the close analogy between the problem of the nuclear macroscopic dissipation function and the problem of the nuclear macroscopic potential energy.

24949 Angular momentum fluctuation energy in the cranking model. Goodman, A.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nucl. Phys., A;* **325**: No. 1, 171-188(13 Aug 1979).

Angular momentum is approximately projected from Hartree-Fock-Bogoliubov cranked (HFBC) wave functions. At each J the projected energy is E/sub proj/approximately E/sub HFBC/. The spin-dependent fluctuation ΔJ includes contributions from J/sub y/ and J/sub z/ as well as J/sub x/. There are no correlations in the three angular momentum components. Projected energies are calculated for ^{168} ^{170}Yb and ^{174}Hf. When compared to experimental energies, the projected spectra are less compressed than the HFBC spectra. At low spins the projected and experimental energies are in good agreement.

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

24950 Experimental limits on deviations from Z^2 dependence of Cerenkov radiation by heavy ions. Salamon, M.H.; Ahlen, S.P.; Tarle, G. (Department of Physics and Space Sciences Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., A;* **21**: No. 5, 1506-1517(May 1980).

We have exposed a variety of Cerenkov radiators to relativistic Ne, Ar, and Fe ions at the Lawrence Berkeley Laboratory's Bevalac and have examined the charge dependence of the Cerenkov emission. Classically, and to first order in relativistic quantum theory, the dependence is Z^2, although certain higher-order corrections suggest a Z^4 dependence as well. Our experimental results are consistent with a pure Z^2 dependence and limits are placed on Z^3 and Z^4 higher-order contributions to Cerenkov emission, whose theoretical bases are briefly discussed. In addition to primary Cerenkov emission, we discuss light sources such as Cerenkov emission by secondary electrons, saturated radiator scintillation, and others which are confronted in most experimental configurations incorporating Cerenkov radiators.

24951 Z dependence of the laser-intensity threshold for inhibited electron thermal conduction. McClellan, G.; Lee, P.H.Y.; Caporaso, G. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). W-740-ENG-48. *Phys. Rev. Lett.;* **44**: No. 10, 658-661(10 Mar 1980).

Temporally resolved sub-kiloelectronvolt x-ray emission pulses have been obtained from disk targets illuminated with 1.06-μm wavelength laser light at 5 x 10^{14} W/cm^2. Striking variations in the x-ray pulse shape from Be, Ti, Sn, Au, and U targets indicate the onset of strongly inhibited electron thermal conduction during the rise of the laser intensity. The laser intensity threshold for this strong inhibition is found to increase with target atomic number Z.

SHIELDING CALCULATIONS AND EXPERIMENTS

REFER ALSO TO CITATION(S) 24057

NEUTRON INTERACTIONS WITH MATTER

24952 (ANL—80-27) **Slow neutron leakage spectra from spallation neutron sources.** Das, S.G.; Carpenter, J.M.; Prael, R.E. (Argonne National Lab., IL (USA)). Feb 1980. Contract W-31-109-ENG-38. 73p. NTIS, PC A04/MF A01.

An efficient technique is described for Monte Carlo simulation of neutron beam spectra from target-moderator-reflector assemblies typical of pulsed spallation neutron sources. The technique involves the scoring of the transport-theoretical probability that a neutron will emerge from the moderator surface in the direction of interest, at each collision. An angle-biasing probability is also introduced which further enhances efficiency in simple problems. These modifications were introduced into the VIM low energy neutron transport code, representing the spatial and energy distributions of the source neutrons approximately as those of evaporation neutrons generated through the spallation process by protons of various energies. The intensity of slow neutrons leaking from various reflected moderators was studied for various neutron source arrangements. These include computations relating to early measurements on a mockup-assembly, a brief survey of moderator materials and sizes, and a survey of the effects of varying source and moderator configurations with a practical, liquid metal cooled uranium source Wing and slab, i.e., tangential and radial moderator arrangements, and Be vs CH_2 reflectors are compared. Results are also presented for several complicated geometries which more closely represent realistic arrangements for a practical source, and for a subcritical fission multiplier such as might be driven by an electron linac. An adaptation of the code was developed to enable time dependent calculations, and investigated the effects of the reflector, decoupling and void liner materials on the pulse shape.

MEDICAL PHYSICS

DOSIMETRY

REFER ALSO TO CITATION(S) 24632, 24722, 24723, 24724

24953 (CONF-7810133—6) **Calculation of dose-rate conversion factors for external exposure to photons and electrons.** Kocher, D.C. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 11p. NTIS, PC A02/MF A01.

From 12. annual symposium of the German Health Physics Society--radioactivity and the environment; Norderney, F.R. Germany (2 Oct 1978).

Methods are presented for the calculation of dose-rate conversion factors for external exposure to photon and electron radiation from radioactive decay. A dose-rate conversion factor is defined as the dose-equivalent rate per unit radionuclide concentration. Exposure modes considered are immersion in contaminated air, immersion in contaminated water, and irradiation from a contaminated ground surface. For each radiation type and exposure mode, dose-rate conversion factors are derived for tissue-equivalent material at the body surface of an exposed individual. In addition, photon dose-rate conversion factors are estimated for 22 body organs. The calculations are based on the assumption that the exposure medium is infinite in extent and that the radionuclide concentration is uniform. The dose-rate conversion factors for immersion in contaminated air and water then follow from the requirement that all of the energy emitted in the radioactive decay is absorbed in the infinite medium. Dose-rate conversion factors for ground-surface exposure are calculated at a reference location above a smooth, infinite plane using the point-kernel integration method and known specific absorbed fractions for photons and electrons in air.

24954 Absorbed dose measurements using parallel plate polystyrene ionization chambers in polystyrene phantoms. Holt, J.G.; Buffa, A.; Perry, D.J.; Ma, I.C.; McDonald, J.C. (Memorial Hospital, New York). Contract EY-76-SO2-3522. *Int. J. Radiat. Oncol., Biol. Phys.;* **5**: No. 11-12, 2031-2038(Nov 1979).

Ionometric methods are commonly used for the routine calibration of high energy photon and electron beams. Since the basis for all ionometric dose measurements for high energy radiation is the Bragg-Gray relation, the dosimeter and phantom used clearly must achieve close approximation to ideal Bragg-Gray conditions. A polystyrene parallel plate ionization chamber used by the authors in polystyrene phantoms is described which closely fulfills the Bragg-Gray conditions. Intercomparison of dose measurements made in a polystyrene phantom with this chamber and a tissue-equivalent (A-150) calorimeter are described for cobalt-60 gamma rays and 10 MV x rays, as well as for 11 MeV electrons and 20 MeV electrons. The agreement between the two methods was within 1.3% or better. From this it is concluded that the use of a polystyrene parallel plate ionization chamber in a polystyrene phantom provides an accurate, reliable and simple method for the calibration of high energy photon and electron beams.

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 24470, 24472

24955 (LA-UR—80-1005) **Model valence-fluctuation systems: variational ground states and magnetic responses.** Brandow, B.H. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 11p. (CONF-800417—2). NTIS, PC A02/MF A01.

From European Physicists Society and Swiss National Science Foundation conference; Zurich, Switzerland (9 Apr 1980).

Variational ground-state wavefunctions are presented and optimized for two model valence-fluctuation systems, based on Anderson lattice Hamiltonians in the $U \rightarrow \infty$ limit. Although these wavefunctions are approximate, they are treated in an essentially exact manner. The $\{f^0, f^1; n = 1\}$ system has an intuitively reasonable ground-state susceptibility, while the $\{f^1, f^2; n = 2\}$ system is found to exhibit an insulating gap. Due to their different crystal symmetries, this gap should be realized in SmB_6 but not in SmS.

24956 Unified model of the smectic-A, nematic, and isotropic phases for bulk, interfaces, and thin films: Bulk. Ronis, D.; Rosenblatt, C. (Department of Chemistry, University of California, Berkeley, California 94720). *Phys. Rev., A;* **21**: No. 5, 1687-1697(May 1980).

A lattice model for three liquid crystalline phases is presented and solved in the mean-field approximation. Numerical results are obtained for the bulk phases. We find isotropic, nematic, and smectic-A phases, with the possibility of nematic-isotropic, smectic-A—isotropic, and nematic—smectic-A (NS) transitions. The NS transition can be first or second order, depending upon the choice of molecular potential. Examples modeling the materials octyl-oxy-cyanobiphenyl (8OCB) and cholersteryl myristate are considered.

24957 Obtaining numerical values for the elliptic emission functions used in calculating electron emission from surfaces. Craig Miller, H. (General Electric Company, Neutron Devices Department, P.O. Box 11508, St. Petersburg, Florida 33733). DE-AC04-76DP00656. *J. Vac. Sci. Technol.;* **17**: No. 3, 691-695(May 1980).

The four elliptic emission functions v(y), t(y), s(y) and $\theta(y)$ [or f/sub m/g(y)] are used in calculating electron emission from surfaces under the influence of temperature and external electric fields. Critical evaluations are made of the published tables of these functions. Several existing approximation equations for the emission functions are given together with some additional polynomial approximations. The estimated accuracies of these approximation equations range from five to six significant figures for the most complex approximations to +- 1% or so for the simplest.

24958 Calculating properties with the coherent-potential approximation. Faulkner, J.S.; Stocks, G.M. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3222-3244(15 Apr 1980).

It is demonstrated that the expression that has hitherto been used for calculating the Bloch spectral-density function A/sup B/(E,k) in the Korringa-Kohn-Rostoker coherent-potential-approximation theory of alloys leads to manifestly unphysical results. No manipulation of the expression can eliminate this behavior. We develop an averaged Green's-function formulation and from it derive a new expression for A/sup B/(E,k) which does not contain unphysical features. The earlier expression for A/sup B/(E,k) was suggested as plausible on the basis that it is a spectral decomposition of the Lloyd formula. Expressions for many other properties of alloys have been obtained by manipulations of the Lloyd formula, and it is now clear that all such expressions must be considered suspect. It is shown by numerical and algebraic comparisons that some of the expressions obtained in this way are equivalent to the ones obtained from a Green's function, while others are not. In addition to studying these questions, the averaged Green's-function formulation developed in this paper is shown to furnish an interesting new way to approach many problems in alloy theory. The method is described in such a way that the aspects of the formulation that arise from the single-site approximation can be distinguished from those that depend on a specific choice for the effective scatterer.

24959 Microscopic theory of thermal desorption and dissociation processes catalyzed by a solid surface. De, G.S.; Landman, U.; Rasolt, M. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332). EG-77-S-05-5489. *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3256-3268(15 Apr 1980).

A microscopic model of thermal desorption and dissociation from metallic surfaces which exhibits explicit dependences on characteristic parameters of the adsorption system is developed. The evaluation of the rates of these processes involves: (i) a derivation of the thermal adatom-solid coupling, (ii) a stochastic incoherent multiphonon mechanism for the evolution of an excitation for bond rupture, and (iii) coupling to final-state reaction channels. Transition probabilities and rates obtained by using both truncated-harmonic and Morse-potential descriptions of the chemisorptive bond are presented and compared with experimental data for xenon and potassium desorption from a tungsten substrate. The results show agreement with experiment and exhibit a linear relationship of the logarithm of the rate versus inverse temperature.

24960 Functional-derivative study of the Hubbard model. III. Fully renormalized Green's function. Arai, T.; Cohen, M.H. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3300-3308(15 Apr 1980).

The functional-derivative method of calculating the Green's function developed earlier for the Hubbard model is generalized and used to obtain a fully renormalized solution. Higher-order functional derivatives operating on the basic Green's functions, G and Γ, are all evaluated explicitly, thus making the solution applicable to the narrow-band region as well as the wide-band region. Correction terms Phi generated from functional derivatives of equal-time Green's functions of th type δ/sup n/ $< N >$ /$\delta\epsilon$/sup n/, etc., with $n >$ or $= 2$. It is found that the Phi's are, in fact, renormalization factors involved in the self-energy Σ and that the structure of the Phi's resembles that of Σ and contains the same renormalization factors Phi. The renormalization factors Phi are shown to satisfy a set of equations and can be evaluated self-consistently. In the presence of the Phi's, all difficulties found in the previous results (papers I and II) are removed, and the energy spectrum ω can now be evaluated for all occupations n. The Schwinger relation is the only basic relation used in generating this fully self-consistent Green's function, and the Baym-Kadanoff continuity condition is automatically satisfied.

24961 Stability of the split-band solution and energy gap in the narrow-band region of the Hubbard model. Arai, T.; Cohen, M.H. (Argonne National Laboratory, Argonne, Illinois 60439). 31-109-ENG-38. *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3309-3319(15 Apr 1980).

By inserting quasielectron energies ω calculated from the fully renormalized Green's function of the Hubbard model obtained in the preceding paper into the exact expression of Galitskii and Migdal, the ground-state energy, the chemical potential, and the dynamic- and thermodynamic-stability conditions are calculated in the narrow-band region. The results show that as long as the interaction energy I is finite, electrons in the narrow-band region do not obey the Landau theory of Fermi liquids, and a gap appears between the lowest quasielectron energy ω and the chemical potential μ for any occupation n, regardless of whether the lower band is exactly filled or not. This unusual behavior is possible because, when an electron is added to the system of N electrons, the whole system relaxes due to the strong interaction, introducing a relaxation energy difference between the two quantities. We also show that all previous solutions which exhibit the split-band structure, including Hubbard's work, yield the same conclusion that electrons do not behave like Landau quasiparticles. However, the energy gap is calculated to be negative at least for some occupations n, demonstrating the dynamic instability of those solutions. They also exhibit thermodynamic instability for certain occupations, while the fully renormalized solution, having sufficient electron correlations built in, satisfies the dynamic and thermodynamic stability conditions for all occupations. When the lower band is nearly filled, the nature of the solution is shown to change, making the coherent motion of electrons with fixed k values more difficult. In the pathological limit where $I = \infty$, however, the gap vanishes, yielding a metallic state.

24962 Quasiparticle excitations, the relaxation, and transport properties in the narrow-band regionof the Hubbard model. Arai, T. (Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3320-3333(15 Apr 1980).

Assuming that, in the narrow-band region, the exact Green's function of the Hubbard model essentially retains the two-peak structure proposed by Hubbard, its consequences are derived as rigorously as possible. When a quasielectron is added to the ground state of N electrons in the narrow-band region of the Hubbard model, the whole system is shown to relax due to the strong interaction I, thus yielding a relaxation energy ΔE between the quasielectron and the original N electrons. This explains the conclusion in the preceding paper that a gap ΔE analogous to the energy gap in superconductivity appears between the quasielectron spectrum and the chemical potential for any occupation n regardless of whether the lower band is exactly filled or not and that the system cannot be a normal metal. It is further found that the ground state is, in fact, a bound state, and electrons involved do not obey the Landau theory of quasiparticles.

24963 Comment on "Correction to Fuchs' calculation of the electrostatic energy of a Wigner solid". Ihm, J.; Cohen, M.L. (Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3754-3756(15 Apr 1980).

It is found that Hall's correction term exactly cancels another electrostatic term in the total energy of the Wigner solid. Although Hall's correction is appropriate for the calculation of the potential at the Wigner lattice site, it is Fuchs' expression which should be used in the total electrostatic energy of the Wigner solid. The origin of the controversy is clarified using physical arguments, and a simpler derivation of Hall's term is presented.

24964 Computer simulation of crack propagation. Paskin, A.; Gohar, A.; Dienes, G.J. (Queens College of the City University of New York, Flushing, New York 11367). DE-AC02-76CH00016. *Phys. Rev. Lett.;* **44**: No. 14, 940-943(7 Apr 1980).

Computer simulations of crack properties were performed on a two-dimensional triangular lattice with a Lennard-Jones interatomic interaction. The use of a long-range potential and an unconstrained sample revealed novel features compared to earlier simulations. The Griffith energy treatment for fracture was found wanting. This system is brittle at low stresses in agreement with the Rice-Thomson criterion and shows dislocation formation at elevated stresses.

24965 Auger lineshape analysis of molecules and solids. Jennison, D.R. (Sandia Laboratories, Albuquerque, New Mexico 87185). DE-AC04-76-DP00789. *J. Vac. Sci. Technol.;* **17**: No. 1, 172-175(Jan 1980).

Considerable recent theoretical work has shown that core—valence—valence Auger lineshape analysis may often be successfully made in terms of the molecular orbital structure of the molecule or the band structure of the solid. This approach assumes a priori that the final state hole motion is uncorrelated. Limitations to this approach include the highly correlated final states observed in ionic and narrow band solids (as Cu). Complications to this approach include the initial state valence screening of the core hole which affects the Auger decay probabilities. However, much useful information about the local density of states (local chemical environment) may be extracted in covalent and metallic materials. Examples from molecular (CH_4, C_2H_4, C_2H_6, and C_3H_8) and solid state (Cu and Be) spectra are presented and the state of our understanding of lineshape analysis is summarized.

24966 Aims and recent accomplishments of surface theory. Feibelman, P.J. (Sandia Laboratories, Albuquerque,New Mexico 87185). DE-AC04-76-DP00789. *J. Vac. Sci. Technol.;* **17**: No. 1, 176-181(Jan 1980).

The goals of surface science include the understanding of surface bonding, structure, transport, and chemistry. However, our present activities are mainly focused on the most basic problem, viz., what are the constituents of a given surface, where are they located and how are they bonded? Theorists are approaching this surface characterization problem from two sides. To make better use of the data available from the many experimental surface probes, we are developing an understanding of the force laws which govern the motion of probe particles near surfaces, and we are studying intensively the relation between the excitation and ground state spectra of a solid. In order to develop a predictive capability regarding surface structure, we are studying a variety of intrinsic surface properties including the nature of bonds at transition metal surfaces, the meaning of bond locality in extended systems, and generally the electronic factors underlying the forces which govern surface geometry. These studies often raise technical issues such as the validity of using local exchange correlation potentials and the applicability of cluster calculations to the analysis of extended surface situations, which, however, should not obscure the main thrust of current work : empirical and predictive surface structure determination. These points will be illustrated with examples from recent research and ways in which experimental surface work might assist theoretical efforts will be indicated.

SOLID STATE PLASMA

24967 Wave-vector decomposition of the exchange and correlation contributions to a metallic surface energy. Rasolt, M.; Geldart, D.J.W. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Rev., B: Condens. Matter;* **21**: No. 8, 3158-3166(15 Apr 1980).

We decompose the lowest-order nonlocal corrections to the local-density approximation to the exchange and correlation component of the metallic surface energy in terms of its wave-vector components. Comparison with the full exchange shows significant improvement over the local-density form. An interpolation between the surface-plasmon-dominated small-wave-vector contributions and the nonlocal correction for large q is suggested, and some of the difficulties inherent in this method are discussed.

SUPERCONDUCTIVITY

GENERAL THEORY

24968 General critical state model in two dimensions and zero applied field: A uniqueness theorem and some consequences. Migliori, A. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). W-7405-ENG. 36. *J. Appl. Phys.;* **51**: No. 6, 3439-3440(Jun 1980).

A general critical state model describes the field and current distributions in a hard Type II superconductor with a local relation between the field and current density. We show here that such models cannot provide a magnetically shielded region in superconducting wires in zero applied field.

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 24362, 24397, 24404, 24434

24969 (LA—8320-PR) LASL Nb_3Ge conductor development. Fourteenth quarterly progress report, October 1-December 31, 1979. Maley, M.P. (comp.). (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 19p. Dep. NTIS, PC A02/MF A01.

The fourteenth quarterly report of the Los Alamos Scientific Laboratory program to develop Nb_3Ge as a superconductor with potential applications to superconducting power transmission lines covers the period Oct. 1-Dec. 31, 1979. Materials research aimed at improving the performance of Nb_3Ge tape conductor is described. A new ac-loss apparatus designed to measure hysteretic and ohmic losses in tape conductors was employed to study the losses in seventeen Nb_3Ge tape samples with currents induced around the circumference of the tapes. Tapes with Nb_3Ge thickness $\leqq$ 3.0 μm have a continuous coating of Nb_3Ge around the edges and that such tapes exhibit low total losses ($\leqq$ 10 $\mu W/cm^2$ at 500 rms A/cm). Thicker layers of Nb_3Ge do not maintain edge integrity and exhibit large ohmic losses caused by the full transport current flowing through the normal substrate. Work on Nb-Ge-Ga ternaries by chemical vapor deposition has concentrated on the preparation of reproducible deposits of A-15 Nb_3Ga.

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

24970 (LA—8310-MS) Evidence for quarks and gluons. Anderson, H.L. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 36p. NTIS, PC A03/MF A01.

The evidence from the experiments of deep inelastic electron and muon scattering and of μ pair production at high energy that the neutron and proton are made of quarks and gluons is given.

RELATIVITY AND GRAVITATION

REFER ALSO TO CITATION(S) 24799, 24876

OPTICS

24971 (LBL—10172) Conventions and formulas for using the Mueller-Stokes calculus in ellipsometry. Hauge, P.S.; Muller, R.H.; Smith, C.G. (IBM Watson Research Center, Yorktown Heights, NY (USA); California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Bell Labs., Murray Hill, NJ (USA)). Dec 1979. Contract W-7405-ENG-48. 41p. (CONF-790857—3). Dep. NTIS, PC A03/MF A01.

From 4. international conference on ellipsometry; Berkeley, CA, USA (20 Aug 1979).

An analysis of the compatability of ellipsometry conventions with the Mueller-Stokes calculus has shown that, for the two approaches to be consistent, modifications to the 1968 Nebraska ellipsometry conventions are necessary. A sign convention is proposed which specifies the ellipticity angle and the fourth Stokes parameter to be positive when the tip of the instantaneous electric-field vector describes a right-handed helix in space. Polarization of this type is designated as right-handed and represented by a point on the northern half of the Poincare sphere. The consequences of using this convention, along with the previously adopted e/sup i(wt + δ)/ convention for the electric field, are seen in the relation among several representations of polarization state. These include the magnitudes and phases of the electric field components, the Jones vector, coherency matrix, Stokes parameters, Poincare sphere, polarization ratio, ellipsometric parameters psi and Δ, and the azimuth and ellipticity of the polarization ellipse. The formalism for converting the Jones matrix into the matrix that transforms the coherency vector or the Stokes vector (Mueller matrix) is described. Mueller matrices for a linear retarder and an isotropic reflecting surface and the description of a compensator-analyzer polarimeter are given. 6 figures.

24972 Exact solutions in the scalar diffraction theory of aberrations. Budgor, A.B. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). W-7405-ENG-48. *Appl. Opt.;* **19**: No. 10, 1597-1600(15 May 1980).

A simple exact method is presented for evaluating the circularly symmetric Fresnel-Kirchhoff diffraction integral in the presence of Seidel aberrations, all orders of spherical aberration, and all orders of linear coma. The resultant formulas involve a simple quadrature over a single special function of mathematics.

24973 Computation of mode properties in optical fiber waveguides by a propagating beam method. Feit, M.D.; Fleck, J.A. Jr. (University of California, Lawrence Livermore Laboratory, P. O. Box 808, Livermore, California 94550). *Appl. Opt.;* **19**: No. 7, 1154-1164(1 Apr 1980).

Propagating beam solutions for optical waveguides can be made to generate such mode-related properties as propagation constants, relative mode powers, and group delays with high precision and considerable flexibility. These quantities are needed in the analysis of optical fiber dispersion. The technique requires the generation of correlation functions from the numerical solutions of a wave equation. These correlation functions are in turn Fourier-transformed with respect ot axial distance z. The resulting spectra display sharp resonances corresponding to mode groups, and the positions and heights of these resonances determine the previously mentioned

mode properties. The spectral analysis is made highly accurate by the use of line-shape fitting techniques. With this method, mode group delays can be determined to a precision of +- 0.12 psec/km using a computation covering a 5-cm propagating path.

MATHEMATICAL PHYSICS

24974 (ANL—80-39) **Numerical methods for a general class of porous medium equations.** Rose, M.E. (Argonne National Lab., IL (USA)). Mar 1980. Contract W-31-109-ENG-38. 80p. NTIS, PC A05/MF A01.

The partial differential equation $\partial u/\partial t + \partial[f(u)]/\partial x = \partial[g(u)\partial u/\partial x]/\partial x$, where g(u) is a non-negative diffusion coefficient that may vanish for one or more values of u, was used to model fluid flow through a porous medium. Error estimates for a numerical procedure to approximate the solution are derived. A revised version of this report will appear in Computers and Mathematics with Applications.

FUSION ENERGY

PLASMA RESEARCH

24975 **Improved equation of state for the classical one-component plasma.** Slattery, W.L.; Doolen, G.D.; DeWitt, H.E. (Los Alamos Scientific Laboratory, Theoretical and Theoretical Design Divisions, Los Alamos, New Mexico 87545). *Phys. Rev., A;* **21**: No. 6, 2087-2095(Jun 1980).

We compute the internal energy of the classical one-component plasma, for values of the Coulomb coupling parameter Γ between 1 and 300, by using converged Monte Carlo chains and a more accurate potential approximation than that used by Hansen. The liquid data are fitted to a simple, very accurate four-parameter formula from which the Helmholtz free energy is derived. The solid data are likewise fitted to a one-parameter formula. The intersection of the two free-energy curves gives an estimate of the fluid-solid transition at Γ = 168 +- 4.

PLASMA CONFINEMENT AND HEATING

REFER ALSO TO CITATION(S) 24999, 25037

24976 **Production of field-reversed mirror plasma with a coaxial plasma gun.** Hartman, C.W.; Shearer, J.W. US Patent Application 022,894. [nd]. 17p.

The use of a coaxial plasma gun to produce a plasma ring which is directed into a magnetic field so as to form a field-reversed plasma confined in a magnetic mirror. Plasma thus produced may be used as a target for subsequent neutral beam injection or other similarly produced and projected plasma rings or for direct fusion energy release in a pulsed mode.

24977 **Generating end plug potentials in tandem mirror plasma confinement by heating thermal particles so as to escape low density end stoppering plasmas.** Baldwin, D.E.; Logan, B.G. US Patent Application 021,293. [nd]. 38p.

The invention provides a method and apparatus for raising the potential of a magnetic mirror cell by pumping charged particles of the opposite sign of the potential desired out of the mirror cell through excitation, with the pumping being done by an externally imposed field at the bounce frequence of the above charged particles. These pumped simple mirror cells then provide end stoppering for a center mirror cell for the tandem mirror plasma confinement apparatus. For the substantially complete pumping case, the end plugs of a tandem mirror can be up to two orders of magnitude lower in density for confining a given center mirror cell plasma than in the case of end plugs without pumping. As a result the decrease in recirculating power required to keep the system going, the technical state of the art required, and the capital cost are all greatly lowered.

24978 (LA—8226-MS) **Relativistic electron beam plasma heating experiment.** Montgomery, M.D.; Parker, J.V. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 12p. NTIS, PC A02/MF A01.

An intense (5 x 10^5 Amp/cm^2), relativistic (5 MeV), electron beam will be used to investigate the heating of small volumes (~ 5 to 10 cm^3) of dense plasma (10^{17} to 10^{18} electrons/cm^3) to kilovolt temperatures via the electrostatic two-stream instability.

24979 (LA—8325-MS) **Ohmic heating of the reversed-field pinch.** Gerwin, R. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 39p. NTIS, PC A03/MF A01.

Simple analytic expressions are found for the global heating rate and the time needed to achieve global power balance with radiation and other losses, in useful agreement with large RFP transport codes. A simple condition is noted, which insures that the heating can be accomplished before appreciable resistive evolution occurs in the pinch profile. The product of poloidal beta, β/sub θ/, and toroidal current, I, that characterizes a condition of global power balance is derived subject to the above-mentioned condition without making key assumptions used by earlier investigators. First, a perfectly steady state (with local power balance) is not assumed, nor is it appropriate to do so. Secondly, the cross-field resistivity is not required to be classical. Since the value of (β/sub θ/ I) plays a fundamental role in determining the kind of device one requires, the foundations of this value are important.

24980 (PPPL—1658) **Vortex formation during rf heating of plasma.** Motley, R.W. (Princeton Univ., NJ (USA). Plasma Physics Lab.). May 1980. Contract AC02-76CH03073. 50p. NTIS, PC A03/MF A01.

Experiments on a test plasma show that the linear theory of waveguide coupling to slow plasma waves begins to break down if the rf power flux exceeds ~ 30 W/cm^2. Probe measurements reveal that within 30 μs an undulation appears in the surface plasma near the mouth of the twin waveguide. This surface readjustment is part of a vortex, or off-center convective cell, driven by asymmetric rf heating of the plasma column.

24981 (UCID—18334) **Buildup studies for MFTF-B.** Gilmore, J.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Apr 1980. Contract W-7405-ENG-48. 54p. Dep. NTIS, PC A04/MF A01.

A one-dimensional radial transport code which was developed to study radial transport in tandem mirror machines has been used to perform buildup studies for the central-cell plasma of the proposed MFTF-B experiment. The effects of the cold, unpumped, neutral gas (which accompanies the hot, neutral-beam injection in the central cell) upon the central-cell plasma have been studied for the low-ϵ (ϵ Identical with (Ω/sub pi//Ω/sub ci/)2) mode and for the two-component mode. A mode here is defined as a particular set of parameters (density, temperature, etc.) under which the experiment will be performed. A very preliminary study of the effects of plateau resonant transport upon the equilibrium plasma obtained for the low-ϵ mode of operation has also been performed.

24982 (UCID—18623) **Rf heating of mirrors.** Porkolab, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Apr 1980. Contract W-7405-ENG-48. 18p. Dep. NTIS, PC A02/MF A01.

A brief overview is presented of potential uses for rf heating of plasmas in mirror devices. While some discussion relating to past experiments is given, the main emphasis is devoted to a review of potential experiments in presently existing devices, and devices under construction or planning. Some predictions are made for plasmas in mirror reactors.

24983 (UCRL—84270) **Heating by the Raman instability.** Estabrook, K.G.; Kruer, W.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Apr 1980. Contract W-7405-ENG-48. 13p. (CONF-800550—1). NTIS, PC A02/MF A01.

From Anomalous absorption meeting; San Francisco, CA, USA (28 May 1980).

Computer simulations are presented of the reflection and heating due to stimulated Raman backscatter of intense laser light in large regions of underdense plasma. The heated electron distribution is found to be approximately a Maxwellian of temperature (m/sub e//2)v/sub p/^{2}, where v/sub p/ is the phase velocity of the electron plasma wave. A simple model of the reflection is presented. Raman may cause a pre-heat problem with large laser fusion reactor targets.

24984 **Theory of electron cyclotron resonance heating of tokamak plasmas.** Ott, E.; Hui, B.; Chu, K.R. (Plasma Physics Division, Naval Reseach Laboratory, Washington, D. C. 20375). *Phys. Fluids;* **23**: No. 5, 1031-1045(May 1980).

A theoretical study of tokamak plasma heating by electron cyclotron resonance is presented. The density limitations imposed by accessibility are first reviewed. Then, the predictions of linear theory (including relativistic effects on the wave absorption) are examined via solutions of the ray equations in a toroidal tokamak equilibrium. These solutions indicate quite favorable characteristics for large tokamaks. Finally, the possibilities of scattering of the incident heating wave by existing drift-wave-type fluctuations and excitation of parametric instability are examined; it is tentatively concluded that parametric instabilities should not be important in typical situations of interest.

24985 **Simulations of the ZT-S reversed field pinch.** Sgro, A.G. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Fluids;* **23**: No. 5, 1055-1061(May 1980).

The implosion and approach to equilibrium of ZT-S reversed field pinch is studied numerically using the Los Alamos Scientific Laboratory one-dimensional hybrid code "aurora." The effects of classical and anomalous transport, impurity radiation, ion-electron thermal equilibration, and wall emission of plasma are considered in the calculations. Simulations of the implosion which assumed classical transport do not agree with the measurements. However, an accurate simulation of both the magnetic field and electron temperature evolution is obtained with anomalous transport and 0.7% oxygen impurity. As equilibrium is approached, the anomalous terms in the transport coefficients decrease and the values of these coefficients become closer to their classical values.

24986 Self-healing of confined plasmas with finite pressure. Coppi, B.; Ferreira, A.; Ramos, J.J. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). E-AC02-78ET53073-A002. *Phys. Rev. Lett.;* **44**: No. 15, 990-993(14 Apr 1980).

At finite ratios of the kinetic plasma pressure to the magnetic pressure, the magnetic confinement configurations of axisymmetric plasma columns tend to acquire characteristics that hinder the onset of instabilities driven by the combined effects of magnetic curvature and pressure gradient. A simple analytical dispersion relation that contains the main physical factors affecting an important class of these modes is given.

24987 ISX-B neutral beam injector experiment on a prototype beam line. Kim, J.; Stirling, W.L.; Menon, M.M.; Dagenhart, W.K.; Barber, G.C.; Davis, R.C.; Haselton, H.H.; Schechter, D.E.; Tsai, C.C. (Oak Ridge National Laboratory, Fusion Energy Division, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **51**: No. 4, 1984-1993(Apr 1980).

Two PLT-injector-type duoPIGatron sources, modified further by shaping the beam-forming apertures, have been tested and experimented on a protype beam line similar to the ISX-B neutral beam injection system. The accelerator column modification has resulted in an increase of the beam power transmission efficiency from that of the straight-bore aperture by 50%. Maximum neutral beam powers achieved on a 28-cm-diam target simulating the ISX-B plasma, located 4.1 m downstream from the source, are ≅910 kW of H^0 at an accelerator power of 42 kV and 61 A and ≅1020 kW of D^0 at 43 kV and 55 A. Measurements have been made to investigate the following: the effects on beam optics of aperture shape, aspect ratio, and different ions (H^+ or D^+); the distribution of beam power deposition along the beam line; ion species compositions; and background pressure behavior due to scrape-off beam particles. The injectors have been shown to be characterized by an optimum perveance of 6 x 10^{-6} AV/sup -3/2/ for an effective extraction area of 142 cm^2 (1799 apertures), which is approximately invariant over the beam energies tried (viz., 25-45 keV).

24988 Heating at the electron cyclotron frequency in the ISX-B tokamak. Gilgenbach, R.M.; Read, M.E.; Hackett, K.E.; Lucey, R.; Hui, B.; Granatstein, V.L.; Chu, K.R.; England, A.C.; Loring, C.M.; Eldridge, O.C.; Howe, H.C.; Kulchar, A.G.; Lazarus, E.; Murakami, M.; Wilgen, J.B. (Naval Research Laboratory, Washington, D.C. 20375). EX-77-A-34-1015;W-7405-ENG-26; ET-78-S-O2-4714. *Phys. Rev. Lett.;* **44**: No. 10, 647-650(10 Mar 1980).

Results are reported of electron-cyclotron-heating experiments in which 80 kW of microwave power from a 35-GHz gyrotron is injected into a tokamak with large single-pass absorption. For 10-ms microwave pulses, incident from the high-field side of the torus, the central electron temperature increases from 850 to 1250 eV, in agreement with empirical transport-code calculations. For the first time it is demonstrated that electron temperature in a tokamak scales linearly with electron-cyclotron-heating power.

24989 Randomness, Maxwellian distributions and resonance absorption. Bezzerides, B.; Gitomer, S.J.; Forslund, D.W. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **44**: No. 10, 651-654(10 Mar 1980).

A capacitor-model plasma simulation and test-particle methods have been utilized to study energy distributions of electrons heated by resonance absorption of intense laser light. Certain subtle properties of the resonantly excited field which introduce a random character to the heating and have a controlling influence on the shape of the distribution have been identified.

24990 Multiple-pass carbon dioxide laser heating of a theta-pinch plasma. Brooks, R.D. Seattle, WA; Univ. of Washington (1979). 150p. University Microfilms Order No. 79-27,751.

Thesis (Ph. D.).

The multiple-pass experiment at the University of Washington consisted of a coupled optical cavity with a 20 cm long theta-pinch plasma as an active optical element. A 100 joule CO_2 TEA laser was used in the coupled cavity with either an eight percent reflecting NaCl output coupler or a thirty percent reflecting germanium output coupler. The NaCl output coupler emphasized the effects of the coupled cavity while the germanium coupler provided significant single-pass as well as multiple-pass heating. The 10.6μ radiation from the TEA laser was focused onto one end of the plasma by a NaCl lens for both single-pass and multiple-pass laser heating. For multiple-pass heating the light diverging from the other end of the plasma was returned to the plasma by a spherical copper mirror. Utilizing holographic interferometry, conditions were found which resulted in the formation of a reproducible plasma with a large density minimum on axis during a major portion of the first quarter-cycle of the theta-pinch discharge.

24991 Numerical simulation of magnetically confined plasmas undergoing cyclotron resonance heating. Daugherty, J.W. Lafayette, IN; Purdue Univ. (1978). 240p. University Microfilms Order No. 79-05,712.

Thesis (Ph. D.).

A set of mathematical and computational tools which can be readily used to study the behavior of magnetically confined plasmas heated by a process known as Electron Cyclotron Resonance Heating (ECRH) is developed. The hot, tenuous plasmas, consisting of electrons and protons, are confined by strong mirror-like magnetic fields. The heating is accomplished by irradiating the plasma with a microwave source whose frequency is adjusted to match the natural cyclotron gyrofrequency of the electrons.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 25009, 25082

24992 (CONF-791058—72) Measurement of the 2.35 MeV window in O + n. Johnson, C.H.; Fowler, J.L.; Hill, N.W.; Ortolf, J.M. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 5p. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

Calculations are made showing that the ion temperature of a deuterium plasma with a Maxwellian distribution can be found by measuring the transmission of the d-d neutrons through liquid oxygen. The method is useful for temperatures up to 6 keV. It does not depend on the absolute neutron yield but does require accurate total neutron cross sections for oxygen. In this experiment the cross section of natural oxygen was measured from 2.0 to 3.0 by neutron time-of-flight at the Oak Ridge Electron Linear Accelerator (ORELA). The fitted cross sections have a 110.9 +- 1.7 mb minimum at 2351.5 keV.

24993 (CONF-800138—1) Evaluation of a high power submillimeter pulsed laser system. Vander Sluis, K.L.; Hutchinson, D.P.; Staats, P.A. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 7p. Dep. NTIS, PC A02/MF A01.

From Japan/US workshop on far-infrared diagnostics; Boston, MA, USA (28 Jan 1980).

This report describes the selection, development, and testing of the system components and presents the power and frequency profiles achieved in tests made on the assembled system. These results, and knowledge gained through design and development work, have suggested improvements in design characteristics to be applied to future research on this diagnostic method. (MOW)

24994 (PPPL—1664) Low energy neutral outflux from the PLT Tokamak. Voss, D.E.; Cohen, S.A. (Princeton Univ., NJ (USA). Plasma Physics Lab.). May 1980. Contract EY-76-C-02-3073. 30p. (CONF-800455—9). NTIS, PC A03/MF A01.

From 4. international conference on plasma surface interactions in controlled fusion devices; Garmisch, F.R. Germany (21 Apr 1980).

A time-of-flight system has been developed to measure the energy spectrum of neutral deuterium atoms emitted from the PLT Tokamak plasma in the energy range 20 to 1000 eV. D^0 neutrals are mechanically chopped by a rotating 25 cm OD stainless steel disc with 24 .025 cm wide slots photo-etched at an 11.4 cm radius. The gated neutrals free stream 181 cm where they impinge on a Cu-Be disc, thereby ejecting secondary electrons which are collected and amplified by an electron multiplier. Since the energy dependence of the Cu-Be secondary emission coefficient as well as the multiplier gain are known from prior calibration, quantitative D^0 fluxes can be determined.

24995 (UCRL—83805) Imaging system for obtaining space- and time-resolved plasma images on TMX. Koehler, H.A.; Frerking, C.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Apr 1980. Contract W-7405-ENG-48. 15p. (CONF-800320—3). NTIS, PC A02/MF A01.

From 3. topical conference on high temperature plasma diagnostics; Los Angeles, CA, USA (17 Mar 1980).

A Reticon 50 x 50 photodiode array camera has been placed on Livermore's Tandem Mirror Experiment to view a 56-cm diameter plasma source of visible, vacuum-ultraviolet, and x-ray photons. The compact camera views the source through a pinhole, filters, a fiber optic coupler, a microchannel plate intensifier (MCPI), and a reducer. The images are digitized (at 3.3 MHz) and stored in a large,

high-speed memory that has a capacity of 45 images. A local LSI-11 microprocessor provides immediate processing and display of the data. The data are also stored on floppy disks that can be further processed on the large Livermore Computer System. The temporal resolution is limited by the fastest MCPI gate. The number of images recorded is determined by the read-out time of the Reticon camera (minimum 0.9 msec). The spatial resolution of approximately 1.4 cm is fixed by the geometry and the pinhole of 0.025 cm. Typical high-quality color representation of some plasma images are included.

24996 Probability distribution of ionized fragments following inner-shell-vacancy creation. Rozsnyai, B.F.; Jacobs, V.L.; Davis, J. (Lawrence Livermore Laboratory, University of California, Livermore, California 94500). *Phys. Rev., A;* **21**: No. 6, 1798-1804(Jun 1980).

The probabilities of differently ionized products following inner-shell-vacancy creation are calculated with account taken of Auger, Coster-Kronig, and radiative transitions. Results of calculations are presented for argonlike ions with different nuclear charges, both in the isolated state and in a plasma environment.

24997 Propagation of light ions in a plasma channel. Olsen, J.N.; Johnson, D.J.; Leeper, R.J. (Sandia Laboratories, Albuquerque, New Mexico 87185). DE-AC04-76-DP00789. *Appl. Phys. Lett.;* **36**: No. 10, 808-810(15 May 1980).

An intense beam of light ions has been propagated 50 cm in a wire-initiated plasma channel in a background of 40 Torr of D_2 gas. A magnetically insulated ion diode was used on the Hydra accelerator (0.3 TW, 1 MV) to inject the beam into the plasma channel. Propagation efficiencies of 80—90% were inferred from carbon activation measurements.

24998 Optimized method of measuring directed electron velocities using the the incoherent regions of laser scattering. Jacoby, B.A.; York, T.M. (Pennsylvania State University, University Park, Pennsylvania 16802). EY-76-S-02-4020. *Appl. Opt.;* **19**: No. 10, 1582-1584(15 May 1980).

With the presumption that a shifted Maxwellian velocity distribution adequately describes the electrons in a flowing plasma, a method with optimum signal to noise resolution to measure directed velocity is described. The lowest velocity that can be determined by this method is shown to depend on the consists of a ruby laser source and two detectors set 180 ^{0} from each other set at 90 ^{0} with respect to the incident laser beam. Simplified analysis compared to standard peak shift detection techniques is seen to be possible using optimization techniques. This proposed method is shown to be superior in SNR for plasma temperature below 7.2 eV.

24999 Soft x-ray imaging instrument for the Alcator A tokamak. Petrasso, R.; Gerassimenko, M.; Seguin, F.H.; Ting, J.; Krogstad, R.; Gauthier, P.; Hamilton, W.; Ramsey, A.; Burstein, P.; Granetz, R. (American Science and Engineering Inc., Cambridge, Massachusetts 02139). *Rev. Sci. Instrum.;* **51**: No. 5, 585-590(May 1980).

We describe an instrument that images the Alcator A tokamak plasma in the soft x-ray energy range with high temporal resolution. Radiation from a cross section of the plasma column is detected by an array of seventeen surface barrier detectors which provides 1 cm poloidal spatial resolution over a 16 cm field of view. The instrument's nominal sensitivity lies in the spectral range from 0.27 to 25 keV; this range includes much of the radiation emitted by the Alcator A plasma, whose core temperature is typically in the 0.6 to 1.1 keV range. The frequency response of the detector-electronics system extends from dc to 170 kHz. We discuss: (1) some design considerations and instrument calibrations, including the instrument's measured response to 0.28, 1.5, 8.0, and 17.5 keV x-rays and its theoretical response to a bremsstrahlung spectrum; (2) the detector-electronics noise levels under various conditions; (3) the instrument's response to an electrically modulated x-ray source; (4) the detector x-ray response as a function of bias voltage and temperature; (5) the detector linearity of response to 1.5 keV x-rays; and (6) the stability of the detector x-ray response despite numerous and prolonged vacuum breaks. Sample data, obtained from Alcator A discharges, are presented.

25000 UHV compatible chopper system. Voss, D.E.; Cohen, S.A. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). EY-76-C-02-3073. *J. Vac. Sci. Technol.;* **17**: No. 1, 303-305(Jan 1980).

A time-of-flight system utilizing a novel mechanical chopper has been developed to measure the energy spectrum of neutral deuterium atoms emitted from a tokamak plasma. The chopper system consists of a motor, a magnetically levitated shaft, and a chopper disk. The disk is rigidly attached to a 159 g shaft assembly and the set is supported against gravity in vacuum by permanent magnets and a stabilizing servosystem (patented by Cambridge Thermionic Corp., Cambridge, MA). All components are UHV compatible to avoid contamination to the tokamak and to the electron multiplier detector. The 25.4-cm-o.d., 0.005-cm-thick, 20 g, 301 stainless-steel chopper disk has 24 0.025-cm-wide slots photoetched at an 11.4-cm radius. An effective aperture time of 0.55 μs is achieved during typical steady-state operation at 22500 rpm with a vacuum pressure of 2 x 10^{-8} Torr.

25001 Vacuum ultraviolet spectroscopic study of plasma impurities in the Tokapole II poloidal. Groebner, R.J. Madison, WI; Univ. of Wisconsin (1979). 232p. University Microfilms Order No. 79-22,806.

Thesis (Ph. D.).

Impurities in tokamak plasmas increase the plasma resistivity, radiate energy out of the plasma, and are implicated in the disruptive instability. Results of a study of plasma impurities in Tokapole II, a tokamak with a four-node poloidal divertor, are reported. The main diagnostics were two vacuum ultraviolet spectrometers, which were used to identify impurities, observe impurity behavior, and measure the line radiated power. Impurity concentrations and the effects of impurities on gross plasma characteristics were determined with an impurity doping technique. The electron temperature was estimated by a time dependent coronal model describing the time history of the oxygen ions, and the ion temperature was obtained from Doppler broadening measurements. Energy loss processes were studied with a power balance analysis.

PLASMA KINETICS - GENERAL

REFER ALSO TO CITATION(S) 24890

PLASMA KINETICS - EXPERIMENTAL

25002 (NRL-MR—4177) XUV spectra of Mo XIII-XVIII. Burkhalter, P.G.; Reader, J.; Cowan, R.D. (Naval Research Lab., Washington, DC (USA)). 11 Mar 1980. Contract EX-76-A-34-1006. 28p. Dep. NTIS, PC A03/MF A01.

Spectral lines from intermediate stages of ionization in Mo were measured and identified. The Mo spectra were observed from a laser-produced plasma and vacuum-spark data. The wavelengths of the $3d^{10}$-$3d^94p$, 4f transitions in Mo XV and the $3p^63d^9$-$3p^53d^{10}$ lines in Mo XVI were measured with an estimated accuracy of +- 0.010A. Line classifications were obtained in complex spectral arrays in Mo XIV-XVIII. These were made with the aid of relativistically-corrected Hartree-Fock calculations. Energy-level diagrams were constructed for the $3d^94p$ and $3d^84f$ configuration in Mo XVI.

25003 (PPPL—1662) Current generation by unidirectional lower hybrid waves in the ACT-1 toroidal device. Wong, K.L.; Horton, R.; Ono, M. (Princeton Univ., NJ (USA). Plasma Physics Lab.). May 1980. Contract EY-76-C-02-3073. 15p. NTIS, PC A02/MF A01.

An unambiguious experimental observation of current generation by unidirectional lower hybrid waves in a toroidal plasma is reported. Up to 10 amperes of current was driven by 500 watts of rf power at 160 MHz.

25004 (SAND—79-2338C) Probe measurements of impurities in the plasma boundary of PLT. Wampler, W.R.; Picraux, S.T.; Cohen, S.A.; Dylla, H.F.; Rossnagel, S.M.; McCracken, G.M. (Sandia National Labs., Albuquerque, NM (USA); Princeton Univ., NJ (USA). Plasma Physics Lab.; UKAEA Culham Lab., Abingdon). 1980. Contract EY-76-C-04-0789. 22p. (CONF-800455—7). NTIS, PC A02/MF A01.

From 4. international conference on plasma surface interactions in controlled fusion devices; Garmisch, F.R. Germany (21 Apr 1980).

Carbon probes were exposed to the plasma edge in PLT at various distances from the plasma and to different numbers (1, 2, 3, 6, 12) of overlayed discharges. The type and areal density of impurities retained were determined using ion backscattering. The principal impurities with $Z > 6$ were found to be O, Fe, Cr, Ti, and Cu in decreasing order of abundance. Fluxes for these impurities at a position close to the wall were found to be respectively 14, 2.8, 0.8, 0.6 and 0.2 x 10^{15}/cm^2 (+- 25%) respectively, compared to the value 2.2 +- .5 x 10^{17} D/cm^{2}s for the deuterium flux at this position. Lateral spreading of the impurity deposition profile behind the probe slit allowed a lower limit to be placed on the impurity mean ion energy. Between the wall and radius of the ring limiter the impurity fluxes increased by a factor of ~ 2 cc.npared to an increase in the D flux by a factor of ~ 5. Since impurity and deuterium fluxes were both measured the effect of sputtering by the incident deuterium on the impurity accumulation can be assessed.

25005 (UCRL—52923) Neutron yield measurements on a TMX endplug. Slaughter, D.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Mar 1980. Contract W-7405-ENG-48. 16p. Dep. NTIS, PC A02/MF A01.

Neutron yield measurements were made on the east endplug of TMX using a calibrated recoil proton counter. The detector consists of a liquid scintillator (NE 213) with a pulse shape discrimination property that allows for identifying photon and neutron interactions. An energy threshold is established to suppress the response to scattered neutrons with energies lower than 1 to 2 MeV.

Results indicate there are typical neutron yields of 2 to 3 x 10^{11} n/s during a 25-ms discharge with 200 A of 20-keV neutral beam injection into the endplug.

25006 (UCRL—84221) **Initial results of the Tandem Mirror Experiment (TMX) at the Lawrence Livermore Laboratory.** Grubb, D.P.; Anderson, C.A.; Casper, T.A.; Clauser, J.F.; Coensgen, F.H.; Correll, D.L.; Cummins, W.F.; Davis, J.C.; Drake, R.P.; Foote, J.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Apr 1980. Contract W-7405-ENG-48. 10p. (CONF-800409—5). Dep. NTIS, PC A02/MF A01.

From International conference on plasma physics; Nagoya, Japan (7 Apr 1980).

Initial experimental results from the Tandem Mirror Experiment (TMX) are presented. Axial profiles of the plasma density and potential necessary for electrostatically enhanced confinement of the central-cell ions have been generated and sustained for the duration of neutral-beam injection. The resulting central-cell ion confinement against axial loss is improved by a factor as large as 9 above that given by magnetic confinement alone. The plasma exhibits gross magnetohydrodynamic stability and microstability. Under some conditions, a residual level of ion cyclotron fluctuations in the end cells heats the central-cell ions and degrades their confinement.

25007 Review of the ISX-B experimental program. Saltmarsh, M.J. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *J. Vac. Sci. Technol.;* **17**: No. 1, 260-267(Jan 1980).

The ISX-B tokamak is a modestly sized device that is designed to explore questions closely related to the design of future tokamak devices, such as the Engineering Test Facility (ETF). The major program emphasis is on high-β plasma operation using neutral beams to heat plasmas with noncircular cross sections. In addition, substantial efforts are under way or planned in the areas of plasma-wall interactions, coated limiter studies, electron—cyclotron heating, ripple injection, impurity flow reversal, pellet injection, and the application of a bundle divertor. The current status and future plans for these programs are reviewed.

25008 Measurement of effective ionization and recombination rate coefficients for intermediate iron ions in a laser generated theta-pinch heated plasma. Brooks, R.L. Jr. College Park, MD; Univ. of Maryland (1978). 88p. University Microfilms Order No. 79-06,637.

Thesis (Ph. D.).

A 2J-Q-switched ruby laser is used to ablate a thin film of iron from a glass substrate, thereby injecting iron into a well-diagnosed theta-pinch plasma. The intensities of various ionization stages are measured as functions of time and interpreted by means of a time-dependent corona ionization-recombination model. By investigating plasmas with varying peak electron density and temperatures, effective rate coefficients are obtained for ionization and recombination. The experimentally determined coefficients for ionization tend to be smaller than presently accepted theoretical values, while those for recombination at electron density n/sub e/ $\simeq$ 3 x 10^{16} cm^{-3} are equal to or smaller than theoretical values for the low density limit.

25009 Laser scattering measurements of plasma turbulence in a fast theta pinch. Gold, S.H. College Park, MD; Univ. of Maryland (1978). 129p. University Microfilms Order No. 79-06,640.

Thesis (Ph. D.).

The Maryland High Voltage Theta Pinch is used to study the turbulent heating of a low density ($\sim$ 1 - 6 x 10^{13} cm^{-3}) cylindrical deuterium plasma by the sudden (tau 1/4 = 300 ns) application of a large (2.5 kG) axial magnetic field. This results in a collisionless imploding shock wave that heats and compresses the plasma. Small angle CO_2 laser scattering, with k λ/sub D/ $<$ 1, can directly sense density fluctuations produced by microinstabilities driven by this magnetic implosion. These microinstabilities are responsible for electron and ion heating. They are also important indirectly, through their influence on the plasma resistivity, in determining gross properties of the theta pinch implosion dynamics. Turbulent density fluctuations were measured at a wavelength near the Debye length at several points within and behind the current sheet of the imploding shock that is driven by the magnetic implosion.

PLASMA KINETICS - THEORETICAL

REFER ALSO TO CITATION(S) 24834

25010 (CONF-791057—4) **Hydrogen recycle modeling in transport codes.** Howe, H.C. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 9p. NTIS, PC A02/MF A01.

From Workshop on hydrogen recycling; Livermore, CA, USA (17 Oct 1979).

The hydrogen recycling models now used in Tokamak transport codes are reviewed and the method by which realistic recycling models are being added is discussed. Present models use arbitrary recycle coefficients and therefore do not model the actual recycling processes at the wall. A model for the hydrogen concentration in the wall serves two purposes: (1) it allows a better understanding of the density behavior in present gas puff, pellet, and neutral beam heating experiments; and (2) it allows one to extrapolate to long pulse devices such as EBT, ISX-C and reactors where the walls are observed or expected to saturate. Several wall models are presently being studied for inclusion in transport codes.

25011 (COO—2218-160) **Cyclotron radiation by a multi-group method.** Chu, T.C. (Illinois Univ., Urbana (USA). Fusion Studies Lab.). 1980. Contract AC02-76ET52040. 86p. NTIS, PC A05/MF A01.

A multi-energy group technique is developed to study conditions under which cyclotron radiation emission can shift a Maxwellian electron distribution into a non-Maxwellian; and if the electron distribution is non-Maxwellian, to study the rate of cyclotron radiation emission as compared to that emitted by a Maxwellian having the same mean electron density and energy. The assumptions in this study are: the electrons should be in an isotropic medium and the magnetic field should be uniform. The multi-group technique is coupled into a multi-group Fokker-Planck computer code to study electron behavior under the influence of cyclotron radiation emission in a self-consistent fashion. Several non-Maxwellian distributions were simulated to compare their cyclotron emissions with the corresponding energy and number density equivalent Maxwellian distribtions.

25012 Self similar solution of plasma equations. Lonngren, K.E. (Wisconsin Univ., Madison (USA). Mathematics Research Center). pp 39-53 of Recent advances in plasma physics. Buti, B. (ed.) (Physical Research Lab., Ahmedabad (India)). Bangalore, India; Indian Academy of Sciences (1977).

From Workshop on plasma physics; Ahmedabad, India (29 Nov 1977).

The technique of self-similar solution of partial differential equations is summarised. Several examples where this technique has been applied to problems in plasma physics are presented.

25013 (LA-UR—80-1109) **Measurements of electron heat flow along a dc magnetic field in strong temperature gradients.** Massey, R.S.; Ingraham, J.C.; Wright, B.L.; Dreicer, H. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 11p. (CONF-800441—4). NTIS, PC A02/MF A01.

From International symposium on physics and open-ended fusion systems; Tsukuba, Japan (15 Apr 1980).

Measurements of electron heat flow parallel to B are performed on a fully -ionized quiescent plasma column under conditions for which the electron-electron collisional mean free path, l/sub ee/, is not small relative to the electron temperature-gradient scalelength. Pulsed microwave heating at one location on the column and nonperturbing microwave resonator measurements of temperature at two locations on the column are used to create and to measure the heat flow. Results are compared with the predictions of a 1-D heat diffusion code that has a parameter, α, multiplying the Spitzer heat conductivity coefficient, and that also has provision for limiting the heat flux to q/sub L/ = βnkT $\sqrt{kt/m}$ (where β is an adjustable parameter) in order to model the transition to larger values of (l/sub ee/T)dT/dx/.

25014 (NRL-MR—4241) **Hard x-ray spectrum from a one-fluid laser plasma model.** Colombant, D.G.; Manheimer, W.M. (Naval Research Lab., Washington, DC (USA)). 27 May 1980. Contract ES-77-A-01-6021. 15p. NTIS, PC A02/MF A01.

Comparisons between hard x-ray experimental spectra and those obtained from a one-dimensional, one-temperature fluid laser-produced plasma model show good agreement over several orders of magnitude in x-ray intensity and for Nd-laser irradiances varying between 1 and 8 x 10^{15} W/cm^2. The key to this agreement is the careful modeling of electron energy flux limitation by return current driven ion acoustic turbulence.

25015 (ORNL/CSD/TM—109) **HLYWD: a program for post-processing data files to generate selected plots or time-lapse graphics.** Munro, J.K. Jr. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 65p. NTIS, PC A04/MF A01.

The program HLYWD is a post-processor of output files generated by large plasma simulation computations or of data files containing a time sequence of plasma diagnostics. It is intended to be used in a production mode for either type of application; i.e., it allows one to generate along with the graphics sequence, segments containing title, credits to those who performed the work, text to describe the graphics, and acknowledgement of funding agency. The current version is designed to generate 3D plots and allows one to select type of display (linear or semi-log scales), choice of normalization of function values for display purposes, viewing perspective, and an option to allow continuous rotations of surfaces. This program was developed with the intention of being relatively easy to use, reasonably flexible, and requiring a minimum investment of the user's time. It uses the TV80 library of graphics software and ORDERLIB system software on the CDC 7600 at the National

Magnetic Fusion Energy Computing Center at Lawrence Livermore Laboratory in California.

25016 (ORNL/TM—7302) **Ring power balance scaling: implications for a reactor.** Uckan, N.A. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 25p. NTIS, PC A02/MF A01.

The existence of a stable equilibrium for the hot electron rings and the ability to sustain them throughout the steady-state operation with reasonably low amounts of microwave power are central to the successful operation of EBTs and to the viability of the EBT reactor concept. In this paper, critical issues and uncertainties are highlighted, and the effects of various parameters and scaling assumptions on the reactor Q/sub E/ (Q/sub electric/) value are indicated.

25017 (PPPL—1659) **Energy principle with global invariants.** Bhattacharjee, A.; Dewar, R.L.; Monticello, D.A. (Princeton Univ., NJ (USA). Plasma Physics Lab.). May 1980. Contract EY-76-C-02-3073. 17p. NTIS, PC A02/MF A01.

A variational principle is proposed for constructing equilibria with low free energy in toroidal plasmas in which relaxation is dominated by a tearing mode of single helicity. States with current density vanishing on the boundary are constructed. Theoretical predictions are compared with experimental data from reversed field pinches and tokamaks.

25018 (UCRL—84044(Rev.1)) **Computational methods for reversed-field equilibrium.** Boyd, J.K.; Auerbach, S.P.; Willmann, P.A.; Berk, H.L.; McNamara, B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Apr 1980. Contract W-7405-ENG-48. 41p. (CONF-800456—1(Rev.1)). Dep. NTIS, PC A03/MF A01.

From Sherwood theory meeting; Tucson, AZ, USA (23 Apr 1980).

Investigating the temporal evolution of reversed-field equilibrium caused by transport processes requires the solution of the Grad-Shafranov equation and computation of field-line-averaged quantities. The technique for field-line averaging and the computation of the Grad-Shafranov equation are presented. Application of Green's function to specify the Grad-Shafranov equation boundary condition is discussed. Hill's vortex formulas used to verify certain computations are detailed. Use of computer software to implement computational methods is described.

25019 **Guiding center drift equations.** Boozer, A.H. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). EY-76-C-02-3073. *Phys. Fluids;* **23**: No. 5, 904-908(May 1980).

The equations for particle drift orbits are given in a new magnetic coordinate system. This form of the equations separates the fast motion along the magnetic field lines from the slow motion across the lines. In addition, less information is required about the magnetic field structure than in alternative forms of the drift equations.

25020 **Steady-state response of the electron distribution function to an applied electric field.** Wiley, J.C.; Hinton, F.L. (Fusion Research Center, The University of Texas at Austin, Austin, Texas 78712). DE-AC05-76ET 53036. *Phys. Fluids;* **23**: No. 5, 921-930(May 1980).

Steady-state solutions to the linearized Fokker—Planck equation have been numerically investigated using two models. The Kulsrud model, in which the electron-electron collision term is simplified by evaluating the integrals using a Maxwellian distribution, is considered first. It is shown that steady-state solutions of the Kulsrud model, obtained by long time integrations of the time dependent equation, can be obtained more easily by considering a separable solution. A more physically reasonable steady-state model, which consistently describes both the thermal and runaway regimes and is readily solved numerically, is developed. The resistivity, in agreement with Spitzer and Haerm, and runaway production rates, in agreement with the Kulsrud model, are obtained.

25021 **Stability of shear flow in a magnetized plasma.** Lau, Y.Y.; Liu, C.S. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Fluids;* **23**: No. 5, 939-941(May 1980).

By studying the eigenmode solutions and by calculating the evolution of an initial wavelet, it is shown that Alfven waves in a magnetized plasma are stable even if the plasma possesses a longitudinal flow velocity v_0 with a strong shear, provided the maximum flow velocity is less than twice the Alfven speed. This result is discussed in the light of recent neutral beam injection experiments in tokamaks.

PLASMA PRODUCTION

25022 **Production of plasma from diatomic gases by relativistic electron beams.** Cary, J.R. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Fluids;* **23**: No. 5, 1005-1011(May 1980).

The theory of the production of plasma by the interaction of a relativistic electron beam with a diatomic gas is presented. The theory includes atomic species as well as molecular species; this is shown to be necessary when nearly fully ionized plasma are produced. In addition, the theory models magnetic field diffusion by an effective time constant, which allows extensive parameter studies to be performed. The dependence of the production process on the beam intensity and width and the gas pressure is presented. It is shown that the thin beams produced by foil-less diodes are not capable of ionizing high pressure ($>$ or $\approx$ 3 Torr) targets.

25023 **High-energy ion expansion in laser-plasma interactions.** Decoste, R. College Park, MD; Univ. of Maryland (1978). 153p. University Microfilms Order No. 79-05,464.

Thesis (Ph. D.).

The high-energy ions produced from the intense laser irradiation (10^{16} W/cm^2 at 1.06 μm) of solid targets are studied both experimentally and theoretically. The ion diagnostics includes both charge collectors and an ion analyzer especially designed for energetic ion studies. Analyzer design considerations are presented together with a calibration technique of the ion detection system involving the measurement of secondary electron emission. A technique using charge exchange to differentiate ion species with the same A/Z but using different Z is also described.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 24978, 24986

25024 (LA—8340-MS) **Growth rates of interchange modes in the dense z-pinch and gas blanket effects.** Suydam, B.R. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 19p. NTIS, PC A02/MF A01.

A class of models of the dense z-pinch in which the bulk of the plasma is neutrally stable against interchange is studied. At a radius a the plasma is abruptly terminated and surrounded by a gas blanket. Instability results from the surface current necessary to maintain pressure balance at the plasma-gas interface. A single dispersion relation applies to all models in this class and shows two effects of the gas blanket in reducing growth rate. (1) Partial support of plasma pressure by external gas pressure reduces the driving force for the instability, and (2) mass loading of the relatively dense neutral gas reduces growth rate.

25025 (MSNW—80-1144-1) **Plasma rotation in reversed-field theta pinches.** Steinhauer, L.C. (Mathematical Sciences Northwest, Inc., Bellevue, WA (USA)). Feb 1980. Contract AC06-76ET53027. 56p. Dep. NTIS, PC A04/MF A01.

Field reversed plasmas have been observed to spin up and develop a destructive rotating $m = 2$ instability. While the instability threshold has been reasonably well characterized, the cause of rotation remains obscure. Of the several mechanisms proposed, one of the most likely is the following: end shorting on open field lines spins up that portion of the plasma; viscous drag then spins up the plasma on closed field lines. We develop theoretical models to describe these processes. The predicted behavior falls into three regimes. For low aspect ratio ($\leqq$ 2.5) the plasma is highly viscous, rotates as a rigid body and spins up to instability in a few Alfven transit times. At intermediate aspect ratio (2.5 to 4) the plasma is weakly viscous; it reaches instability in the viscous transfer time which lengthens very rapidly for higher aspect ratio. At high aspect ratio ($\geqq$ 4) spin up is slower than the resistive decay of the plasma, and instability should not arise.

25026 (PPPL—1663) **N-dependence of ballooning instabilities.** Dewar, R.L.; Manickam, J.; Grimm, R.C.; Chance, M.S. (Princeton Univ., NJ (USA). Plasma Physics Lab.). May 1980. Contract EY-76-C-02-3073. 27p. NTIS, PC A03/MF A01.

The critical β for stability against ideal hydromagnetic internal ballooning modes as a function of toroidal mode number, n, is calculated for two different equilibrium sequences by use of a finite element technique ($n \leqq 20$), and a WKB formalism ($n \geqq 5$). The agreement between the two methods is good in the overlap region $5 \sim \leqq n \sim \leqq 20$. The WKB formula reduces to the 1/n correction at very high n, but is much more accurate at moderate n. The critical β vs n curves exhibit oscillatory structure at low n, but in both sequences the lower bound on β/sub c/ $\sim$ 5%. For reactor parameters, finite Larmor radius effects are not expected to have a large effect on this β-limitation.

25027 **Local sufficient condition for magnetohydrodynamic stability of closed line systems.** Hameiri, E. (Courant Institute of Mathematical Sciences, New York University, New York, New York 10012). EY-76-C-02-3077. *Phys. Fluids;* **23**: No. 5, 889-894(May 1980).

A sixth-order system of ordinary differntial equations along field lines is shown to have lower energy than the full magnetohydrodynamic system and thus offers a sufficient condition

for stability. The two energies agree for all modes localized on field lines so that our criterion appears to be not overly restrictive. It is indeed the most optimistic sufficient condition in the literature. The criterion can be reduced to an eigenvalue problem of a single second-order integro-differential equation.

25028 Persistence of magnetohydrodynamic stability in field reversed pinches against microinstability. Hamasaki, S.; Krall, N.A.; McBride, J.B. (Science Applications, Inc., La Jolla, California 92037). DE-AC03-79-ET53057. *Phys. Fluids;* **23**: No. 5, 895-897(May 1980).

The question of the persistance of magnetohydrodynamic stable profiles in reversed field Z pinches is addresses considering the probability of enhanced transport due to various microinstabilities. It is found that Suydam's criterion for magnetohydrodynamic stability usually requires sufficient magnetic shear to prevent microinstabilities throughout most of the radial profiles.

25029 Simulation of drift-cone modes. Cohen, B.I.; Maron, N. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). W-7405-ENG-48. *Phys. Fluids;* **23**: No. 5, 974-980(May 1980).

Simulations of the drift-cone instability in a uniform magnetic field have shown agreement with the nonlinear theory of Myer and Simon (but only for a single mode and a weakly unstable, partially filled loss-cone velocity distribution) and with a theory that invokes ion trapping and a simple free-energy argument (for a spectrum of modes and for severe loss-cone distributions). These simulations have been performed with a particle-fluid hybrid code.

25030 Stability of long, thin axisymmetric mirror machines. Weitzner, H. (Courant Institute of Mathematical Sciences, New York University, New York, 10012). EY-76-C-02-3077. *Phys. Fluids;* **23**: No. 5, 1046-1054(May 1980).

The guiding center plasma model is used in the long, thin approximation to study the stability of axisymmetric mirror machines. A special case of an energy principle of Newcomb is derived and applied to the problem. It is shown that within the approximation there exist stable axisymmetric mirrors for plasma betas less than some positive number. The magnetic fields used have a weak singularity at one point on the very outer edge of the plasma. The fields are continuous, but the gradients of the field become infinite. The possibilities of eliminating such a singularity are discussed.

25031 Shear stabilized cylindrically symmetric mirror plasma. Manheimer, W.M. (Naval Research Laboratory, Washington, D. C. 20375). *Phys. Fluids;* **23**: No. 5, 1067-1068(May 1980).

The possibility of shear stabilization of a cylindrically symmetric mirror plasma is examined.

25032 Ion-acoustic double layers. Sato, T.; Okuda, H. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). EY-76-C-02-3073. *Phys. Rev. Lett.;* **44**: No. 11, 740-743(17 Mar 1980).

It is found, by means of numerical simulations, that an ion-acoustic instability (v/sub d/$<$v/sub t/e) results in the formation of double layers in a sufficiently long system. Anomalous resistivity generated by the ion-acoustic instability causes the buildup of a dc potential which in turn accelerates electrons further to enhance the original instability leading to the formation of double layers.

25033 Study of MHD instabilities in elongated tokamaks. An, C.H. Knoxville, TN; Univ. of Tennessee (1979). 116p. University Microfilms Order No. 79-27,023.

Thesis (Ph. D.).

Fixed boundary ideal MHD instabilities are studied analytically and computationally for highly elongated axisymmetric toroidal equilibria. The computational studies of $n = 1$ large-scale instabilities show that even a slightly diamagnetic plasma with broad current profile and highly elongated cross section is subject to ballooning modes for q values well above unity at the magnetic axis. The maximum stable average betas are achieved with a broad current profile and either a paramagnetic plasma (β/sub p/ < 1) with a highly elongated cross section (b/a $\cong 3$) or a diamagnetic plasma (β/sub p/ > 1) with only a mildly elongated cross section (b/a < 2). In the analytic study of high n ballooning modes, the marginal pressure gradient is derived as a function of equilibrium parameters such as safety factor, shift, elongation, and inverse aspect ratio.

25034 Characteristics and lifetime of convective plasma motions in tokamaks. Hassam, A.B.S. Princeton, NJ; Princeton Univ. (1978). 122p. University Microfilms Order No. 79,05-626.

Thesis (Ph. D.).

Part I considers the time evolution, due to dissipative processes, of an initial pattern of poloidal and toroidal flows in a tokamak. The calculation is applicable to collisional, low β, axisymmetric tokamaks of arbitrary minor cross section. Time rates of change of poloidal flows which are subsonic but larger than the diamagnetic speed are given according to the magnitude of the flow and the collisionality of the plasma. Part II examines the effects of a magnetic field inhomogeneity on convective cells and their collective transport. A slab calculation shows, firstly, that the convective cell, which is a zero-frequency mode of the homogeneous plasma, is transformed into the interchange mode in a system with an inhomogeneous magnetic field. Secondly, in the inhomogeneous field, the convective cell damps by magnetic pumping at a rate much faster than perpendicular viscous damping (for tokamak-like parameters). Part III investigates some general properties of a time-stationary, nonaxisymmetric, hydromagnetic equilibrium with flow. A subsonic flow is considered as a perturbation to the ideal magnetostatic equilibrium. The consistency conditions necessary to solve the resulting set of equations, to second order in the flow magnitude, are obtained.

PLASMA WAVE PHENOMENA

REFER ALSO TO CITATION(S) 25003, 25021, 25029

25035 Kinetic properties of Alfven waves. Hasegawa, A. (Bell Labs., Murray Hill, NJ (USA)). pp 65-88 of Recent advances in plasma physics. Buti, B. (ed.) (Physical Research Lab., Ahmedabad (India)). Bangalore, India; Indian Academy of Sciences (1977).

From Workshop on plasma physics; Ahmedabad, India (29 Nov 1977).

Linear and nonlinear properties of the Alfven wave in a collisionless, magnetized plasma are presented. The resonant absorption of a magnetohydrodynamic Alfven wave in a nonuniform plasma is shown to be a manifestation of the resonant mode conversion of the magnetohydrodynamic mode into the kinetic Alfven wave. Using the quasilinear theory, it is shown that the kinetic Alfven wave turbulence can cause various anomalous transport phenomena such as anomalous diffusion, anamalous viscosity and resonant heating. The nonlinear wave-wave and wave-particle interactions are discussed in the context of the interactions of two kinetic Alfven waves with an ion acoustic wave (stimulated Brillouin scattering) or with ions (stimulated Compton scattering). It is shown that the nonlinear coupling coefficient is larger than that of a magnetohydrodynamic Alfven wave by a factor of ωsub(ci)/ω, where ωsub(ci) and ω are the ion cyclotron frequency and the Alfven wave frequency. The kinetic Alfven wave is shown to have an exact solitary wave solution that propagates in a direction oblique to the ambient magnetic field. The application of the kinetic Alfven wave to heat a Tokamak-type plasma to the thermonuclear temperature is considered. In spite of the drawback that the coupling coil should be installed inside the plasma chamber, this heating method is shown to be superior to other RF heating schemes as well as to the neutral beam heating. Only the RF field (approximately 1 MHz) of a magnetic field amplitude of four Gauss is shown to be needed to provide 200 MW RF Power to a reactor size plasma.

25036 Critical survey of ion-acoustic waves. Alexeff, Igor (Tennessee Univ., Knoxville (USA). Dept. of Electrical Engineering). pp 131-136 of Recent advances in plasma physics. Buti, B. (ed.) (Physical Research Lab., Ahmedabad (India)). Bangalore, India; Indian Academy of Sciences (1977).

From Workshop on plasma physics; Ahmedabad, India (29 Nov 1977).

Interesting phenomena occurring in ion-acoustic waves are briefly described. The need for further research in these areas is stressed.

25037 Numerical analysis of high power laser propagation in magnetized plasmas. Druce, R.L.; Kristiansen, M.; Hagler, M.O. (Texas Tech Univ., Lubbock (USA). Dept. of Electrical Engineering). pp 165-173 of Recent advances in plasma physics. Buti, B. (ed.) (Physical Research Lab., Ahmedabad (India)). Bangalore, India; Indian Academy of Sciences (1977).

From Workshop on plasma physics; Ahmedabad, India (29 Nov 1977).

A computer code developed to predict laser-plasma interaction in cylindrical magnetized plasmas is described. Two problems of interest have been studied viz., the bleaching wave behaviour and a comparison with experimental results obtained in earlier investigations. The agreement with experiment is found to be fairly good.

25038 Wave-energy density and wave-momentum density of each speciesof a collisionless plasma. Cary, J.R.; Kaufman, A.N. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., A;* **21**: No. 5, 1660-1663(May 1980).

Expressions for the wave-energy density and wave-momentum density of each species of a collisionless plasma are derived. The sum of the wave-energy (momentum) densities of all the species and the electromagnetic-energy (momentum) density gives the previously known result for the total wave-energy (momentum) density of a dispersive medium.

25039 Method of evaluating the effects of particle scattering by fluctuations. Hershcovitch, A. (Plasma Dynamics Laboratory, Rensselaer Polytechnic Institute, Troy, New York 12181). EY-76-5-02-2229.0000. *Phys. Fluids;* **23**: No. 5, 942-944(May 1980).

A simple and heuristic procedure for computing an effective scattering frequency of particles by low frequency waves is outlined. Application to an experiment and a computer simulation yield good agreement.

25040 Convective amplification of drift waves and thermal fluctuation levels in a stable plasma. Waltz, R.E.; Pfeiffer, W.; Dominguez, R.R. (General Atomic Company, San Diego, California 92138). DE-AT03-76ET51011. *Phys. Fluids;* **23**: No. 5, 985-991(May 1980).

The possibility that convective amplification of drift waves gives rise to significant thermal fluctuation levels in a stable tokamak plasma is investigated. A test particle formulation yields a differential dispersion equation, which is amenable to numerical solution. It is found that, for realistic tokamak parameters, the calculated thermal fluctuation levels are far below those measured experimentally. Convective amplifications are localized and relatively small. The largest calculated fluctuation levels are due to an enhancement of the thermal source strength for frequencies near the eigenfrequencies of weakly damped normal modes.

25041 Inverse synchrotron interaction. Pantell, R.H.; Edighoffer, J.A. (Department of Electrical Engineering, Stanford University, Stanford, California 94305). *J. Appl. Phys.;* **51**: No. 4, 1905-1908(Apr 1980).

An analysis is given for the energy exchange between a focused laser beam and free relativistic electrons in a circular orbit in a uniform magnetic field. Curves are presented to illustrate the dependence of this coupling on the various system parameters. Applications for inverse synchrotron interaction include electron acceleration and amplification of electromagnetic radiation.

25042 Oscillations and waves in anisotropic plasmas. Arthur, M.D. Blacksburg, VA; Virginia Polytechnic Inst. and State Univ. (1979). 114p. University Microfilms Order No. 79-24,087.

Thesis (Ph. D.).

The linearized Vlasov-Maxwell equations describing anisotropic plasma oscillations and waves are studied using an operator theoretic approach. The model considered is one dimensional so that after velocity averages perpendicular to this direction have been taken, the equations can be naturally grouped into one set of equations for longitudinal modes and another set of equations for transverse modes.

25043 Observations of plasma wave states. Bengtson, R.D.; Sanchez, A. (Texas Univ., Austin (USA). Dept. of Physics). pp 137-144 of Recent advances in plasma physics. Buti, B. (ed.) (Physical Research Lab., Ahmedabad (India)). Bangalore, India; Indian Academy of Sciences (1977).

From Workshop on plasma physics; Ahmedabad, India (29 Nov 1977).

The development of a high frequency plasma wave structure with finite energy levels which originates during the formation of a plasma is described. The helium satellite technique used in these observations is discussed.

FUSION POWER PLANT TECHNOLOGY

REFER ALSO TO CITATION(S) 23847

25044 (CONF-791102—163) **Evaluation of the impact of a committed site on fusion reactor development.** Reid, R.L.; Nagy, A. (Oak Ridge National Lab., TN (USA); Bechtel National, Inc., San Francisco, CA (USA)). 1979. Contract W-7405-ENG-26. 4p. Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

The technical and economic merits of a committed fusion site for development of tokamak, mirror, and EBT reactor from ignition through demo phases were evaluated. Schedule compression resulting from evolving several reactor concepts and/or phases on a committed site as opposed to sequential use of independent sites was estimated. Land, water, and electrical power requirements for a committed fusion site were determined. A conceptual plot plan for siting three fusion reactors on a committed site was configured. Reactor support equipment common to the various concepts was identified as candidates for sharing. Licensing issues for fusion plants were briefly addressed.

25045 (UCRL—84245) **Some implications for mirror research of the coupling between fusion economics and fusion physics.** Post, R.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-48. 28p. (CONF-800441—6). NTIS, PC A03/MF A01.

From International symposium on physics and open-ended fusion systems; Tsukuba, Japan (15 Apr 1980).

The thesis is made that physics understanding and innovation represent two of the most important ingredients of any program to develop fusion power. In this context the coupling between these and the econmics of yet-to-be realized fusion power plants is explored. The coupling is two-way: realistic evaluations of the economic (and environmental) requirements for fusion power systems can influence the physics objectives of present-day fusion research programs; physics understanding and innovative ideas can favorably impact the future economics of fusion power systems. Of equal importance is the role that physics/innovation can have on the time scale for the first practical demonstration of fusion power. Given the growing worldwide need for long-term solutions to the problem of energy it is claimed to be crucial that fusion research be carried out on a broad base and in a spirit that both facilitates the growth of physics understanding and fosters innovation. Developing this theme, some examples of mirror-based fusion system concepts are given that illustrate the coupling here described.

25046 Plasma confinement apparatus using solenoidal and mirror coils. Fowler, T.K.; Condit, W.C. (to Dept. of Energy). US Patent 4,166,760. 4 Sep 1979. Filed date 4 Oct 1977. 10p.

PAT-APPL-839,226.

A plasma confinement apparatus is described, wherein multiple magnetic mirror cells are linked by magnetic field lines inside of a solenoid with the mirroring regions for adjacent magnetic mirror cells each formed by a separate mirror coil inside of the solenoid. The magnetic mirror cells may be field reversed.

BLANKET ENGINEERING

REFER ALSO TO CITATION(S) 25062

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 24513

25047 (CONF-791102—164) **Progress on large superconducting toroidal field coils.** Haubenreich, P.N.; Luton, J.N.; Thompson, P.B.; Beard, D.S. (Oak Ridge National Lab., TN (USA); Department of Energy, Washington, DC (USA). Office of Fusion Energy). 1979. Contract W-7405-ENG-26. 4p. Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

Large superconducting toroidal field coils of competing designs are being produced by six major industrial teams. In the US, teams headed by General Dynamics Convair, General Electric, and Westinghouse are under contract to design and fabricate one coil each to specifications established by the Large Coil Program. A facility for testing 6 coils in a toroidal array at fields to 8 to 12 tesla is under construction at Oak Ridge. Through an international agreement, EURATOM, Japan, and Switzerland will produce one coil each for testing with the US coils. Each test coil will have a 2.5 x 3.5 m D-shape winding bore and is designed to operate at a current of 10 to 18 kA at a peak field of 8T while subjected to pulsed fields of 0.14 T applied in 1.0 s. There are significant differences among the six coil designs: five use NbTi, one Nb_3Sn; three are cooled by pool boiling helium, three by forced flow; five have welded or bolted stainless steel coil cases, one has aluminum plate structure. All are designed to be cryostable at 8T, with structural margin for extended operation. The three US coil teams are almost or completely finished with detailed design and are now procuring materials and setting up manufacturing equipment. The non-US teams are at various stages of verification testing and design. The GDC and GE coils are scheduled for delivery in the spring of 1981 and the others will be completed a year later. The 11-m diameter vessel at the test facility has been completed and major components of the test stand are being procured. Engineering and procurement to upgrade the helium liquifier-refrigerator system are under way.

25048 (CONF-791102—167) **Eddy current heating of irregularly shaped plates by slow ramped fields.** Dresner, L. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 5p. Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

Theorems are presented for estimating eddy current heating of irregularly shaped plates by a perpendicular ramped field. The theorems, which are derived from two complementary variational principles, give upper and lower bounds to the eddy current heating. Illustrative results are given for rectangles, isosceles triangles, sectors of circular annuli, rhombuses, and L-shaped plates. A comparison is made with earlier work.

25049 (LA-UR—80-1104) **Production of field-reversed configurations with a magnetized coaxial plasma gun.** Jarboe, T.R.; Henins, I.; Hoida, H.W.; Linford, R.K.; Marshall, J.; Platts, D.A.; Sherwood,

A.R. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 10p. (CONF-800441—5). NTIS, PC A02/MF A01.

From International symposium on physics and open-ended fusion systems; Tsukuba, Japan (15 Apr 1980).

Compact toroids were generated which can be made to come to rest in a cylindrical resistive flux conserver. They are observed to rotate so that their major axis is perpendicular to the axis of the flux conserver. Subsequently they appear to remain stationary and decay with a time constant of about 100 μs. We have also generated compact toroids in an oblate geometry which remain aligned with the axis of the flux conserver and decay with a time constant of 150 μs. The magnetic field reconnection time for compact toroid formation is measured in the latter case to be much shorter than the decay time.

25050 (UCID—18614) **Adiabatic compression of field-reversed plasma.** Shearer, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Apr 1980. Contract W-7405-ENG-48. 20p. Dep. NTIS, PC A02/MF A01.

Field-reversed plasma compression occurs in a number of different contexts. Theta pinches are compressed by a time-increasing magnetic field, produced either by a large power supply or by a moving conductor (liner). A moving field-reversed plasma that encounters an increasing magnetic mirror field also experiences compression due to the increase in the local field as seen by the plasma. This interaction occurs at the entrance to the moving ring reactor and in the BETA-II plasma ring injection experiment. The adiabatic compression of the moving ring is considered by means of some dimensional scaling rules.

25051 (UCID—18615) **Estimation of neutral-beam-induced field reversal in MFTF by an approximate scaling law.** Shearer, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Apr 1980. Contract W-7405-ENG-48. 38p. NTIS, PC A03/MF A01.

Scaling rules are derived for field-reversed plasmas whose dimensions are common multiples of the ion gyroradius in the vacuum field. These rules are then applied to the tandem MFTF configuration, and it is shown that field reversal appears to be possible for neutral beam currents of the order of 150 amperes, provided that the electron temperature is at least 500 eV.

POWER SUPPLIES, ENERGY STORAGE

25052 (CONF-791102—166) **1000-kVA arc power supply.** Wright, R.E.; Barber, G.C.; Ponte, N.S. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 3p. Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

Because of ever-increasing power demands for the development of the Oak Ridge duoPIGatron ion source, a continuous-duty arc power supply was constructed for the Medium Energy Test Facility (METF) to furnish power for the plasma generator of experimental ion sources. The power supply utilizes 12-pulse rectification with half-wave switching in a delta and wye full-wave bridge that may be connected in series or parallel. It will deliver 340 V dc, 2500 A to an ion source when series connected and 170 V dc, 5000 A when paralleled connected. Silicon-controlled rectifiers (SCR) in each rectifier bridge can be switched for pulses as short as 10 ms through continuous duty. The filter section that reduces the ripple in the output consists of an inductor-to-capacitor (L-C) filter to smooth the 720-Hz pulses. The power transformer serves as an isolation transformer allowing the secondary to be elevated to the accelerating potential of the ion source. The dc output level is controlled with a 1000-kVA auto transformer connected to the primary of the power transformer. All elevated voltages and currents are monitored at ground potential with an optical telemetry system. This paper describes the power supply in detail, including block diagrams, component specifications, and waveforms when supplying power to an ion source.

25053 **Contacts for pulsed high current: design and test.** Wildi, P. (Univ of Tex, Austin). pp 195-197 of IEEE International Pulsed Power Conference. Guenther, A.H. (ed.). New York, NY; Inst. of Electrical and Electronics Engineers (1979).

From Pulsed power conference; Lubbock, TX, USA (12 Jun 1979).

The Texas Fusion Plasma Research Tokamak required the development of a special contact for pulsed high currents for the split coils of the poloidal system at a location which is highly inaccessible. A solution was found in the form of a special plug contact. A prototype was tested to the failure point using the discharge of a homopolar machine. Design, test settest results are described and the results are evaluated in view of other uses such as larger contacts and switches.

25054 **Status of the upgraded version of the NRL GAMBLE II pulse power generator.** Boller, J.R.; Burton, J.K.; Shipman, J.D. Jr. (Nav Res Lab, Washington, DC). pp 205-208 of IEEE International Pulsed Power Conference. Guenther, A.H. (ed.). New York, NY; Inst. of Electrical and Electronics Engineers (1979).

From Pulsed power conference; Lubbock, TX, USA (12 Jun 1979).

The GAMBLE II water dielectric pulse power generator, in 1970, was the forerunner of the high energy (>50 kJ) class of water dielectric generators. It has been redesigned internally to make maximum use of its original outer conductor shell adn to optimize it for the positive polarity mode of operation for ppositive polarity mode of operation for positive ion beam experimentation. The new design also initiates the use of an oil dielectric multi-channel switch at the output of the pulse forming line. This switch, because of its low capacitance, eliminates the need for an extra prepulse switch. The upgraded version has been tested up to power and energy levels which are nearly twice the original.

25055 **High power very long pulse testing of a 200 kv. tetrode regulation tube.** Stabley, J.D.; Gray, B. (RCA). pp 242-245 of IEEE International Pulsed Power Conference. Guenther, A.H. (ed.). New York, NY; Inst. of Electrical and Electronics Engineers (1979).

From Pulsed power conference; Lubbock, TX, USA (12 Jun 1979).

Tests at very long pulse lengths were conducted to evaluate the design concepts of the S94000E regulator tube. The S94000E is a liquid-cooled ceramic to metal beam power tetrode that utilizes thoriated tungsten filaments in a circular array of unit electron optical systems. Voltages as high as 200 kv have been switched for pulse lengths of 0.5 second and at anode dissipation levels that exceeded 2.0 million watts. Tubes similar to the one tested will be employed as series regulators in the TOKAMAK Fusion Test Reactor. This paper discusses the tube, test results, and operational experiences associated with those tests.

25056 **Inductive storage-prospects for high power generation.** Burton, J.K.; Conte, D.; Ford, R.D.; Lupton, W.H.; Scherrer, V.E.; Vitkovitsky, I.M. (Nav Res Lab, Washington, DC). pp 284-286 of IEEE International Pulsed Power Conference. Guenther, A.H. (ed.). New York, NY; Inst. of Electrical and Electronics Engineers (1979).

From Pulsed power conference; Lubbock, TX, USA (12 Jun 1979).

Recent progress in the development of key elements of high power inductive storage systems makes it possible to generate high power pulses using energy storage systems (other than explosive generators) that include single-plus inductive systems, hybrids (inductor/pulse line and inductive devices for steepening of the capacitor output) as well as inductive system for generation of high power pulse trains. Prospects for further development of opening switches and storage systems suggest potential near-term payoff. Improvements based on such developments can be expected to affect system efficiency, compactness and operational convenience. 15 refs.

25057 **Rebuilding the five megajoule homopolar machine at the university of texas.** Gully, J.H.; Tolk, K.M.; Zowarka, R.C.; Brennan, M.; Bird, W.L.; Weldon, W.F.; Rylander, H.G.; Woodson, H.H. (Univ of Tex, Austin). pp 325-329 of IEEE International Pulsed Power Conference. Guenther, A.H. (ed.). New York, NY; Inst. of Electrical and Electronics Engineers (1979).

From Pulsed power conference; Lubbock, TX, USA (12 Jun 1979).

The role of the 5 MJ homopolar machine at the Center for Electromechanics has changed from that of a pulsed power supply experiment to that of a power supply for various experiments. Because of this change in duty, it wanecessary to modify the machine to allow more efficient operation and easier connection of the machine to the load. The experimental bearings which were on the machine were replaced with bearings of a more conventional design. These bearings exhibit a higher stiffness and lower loss than the original bearings, making the machine more reliable and reducing motoring time. The surface of the poles were faced to make the applied field more uniform over the face of the rotor. This reduced the magnetic momentrotor and reduced the side forces on the rotor during discharge. The busbars were rebuilt to lower the resistance of the output circuit and to allow quicker change of experiments. The latching mechanism of the closing switch was rebuilt for better reliability and a damper was added to lower the mechanical shock on the switch during operation.

25058 **Computer based electrical analysis of homopolar generator driven, bitter plate storage inductors with radial current diffusion.** Mayhall, D.J.T.; Rylander, H.G.; Weldon, W.F.; Woodson, H.H. (Univ of Tex, Austin). pp 330-332 of IEEE International Pulsed Power Conference. Guenther, A.H. (ed.). New York, NY; Inst. of Electrical and Electronics Engineers (1979).

From Pulsed power conference; Lubbock, TX, USA (12 Jun 1979).

Maxwell's equations are solved for the operational admittance in the magnettic quasi-static approximation for nonmagnetic cylindrical coils with aximuthal currents and axial magnetic fields. An infinite seriBessel function solution is obtained and solved for copper

coils with given radial dimensions. Coil turns numbers and lengths are design parameters. A multiple branch, shunt network coil model with series resistances and inductances is derived. A 5 MJ homopolar generator is modeled with a torque-speed equation including brush and seal drag torques. The brush contact voltage drop is modeled versus surface speed and brush current. Transmission system resistances and inductances are included. Effectof current penetration, effective coil resistances and inductances, and peak temperatures are calculated versus time. Coil currents and voltages are obtained, as are system energy storages and dissipations. Peak current times and system discharge times are determined. Slightly underdamped configurations are found.

25059 Testing and analysis of a fast discharge homopolar machine (fdx). Bullion, T.M.; Zowarka, R.; Driga, M.D.; Gully, J.H.; Rylander, H.G.; Tolk, K.M.; Weldon, W.F.; Woodson, H.H. (Univ of Tex, Austin). pp 333-342 of IEEE International Pulsed Power Conference. Guenther, A.H. (ed.). New York, NY; Inst. of Electrical and Electronics Engineers (1979).

From Pulsed power conference; Lubbock, TX, USA (12 Jun 1979).

The Fast Discharge Experiment (FDX) is a 0.36 MJ, 200 v homopolar machine designed to discharge in the millisecond. This experiment is intended to establish the fundamental limitations involved in extracting energy in the shortest time froa flywheel using homopolar conversion. FDX features a room temperature 1.6*10;sup 6;;implied by;A-t copper coil pulsed by a 5 MJ slow discharge homopolar machine, two 30.5 cm diameter counterrotating aluminum rotors with flame sprayed copper slip rings, low inductance return conductors, coaxial transmission line, four fast closing (30 ;mu;sec) 1/2 Ma making switches, hydrostatic journal bearings, squeeze film thrust bearings and dual brush activation systems. After initial testing of FDX was completed and data was analyzeproblems limiting performance were identified. Various components of the machine were redesigned and modified to correct these problems. A second set of tests, including short circuit discharges from various speeds, has recently been conducted. Results and analysis of these tests are presented. New problems encountered as well as recommendations for additional work will also be given.

25060 Preliminary inductive energy transfer experiments. Henderson, R.P.; Smith, D.L.; Reinovsky, R.E. (Air Force Weapons Lab, Kirtland AFB, NM). pp 347-349 of IEEE International Pulsed Power Conference. Guenther, A.H. (ed.). New York, NY; Inst. of Electrical and Electronics Engineers (1979).

From Pulsed power conference; Lubbock, TX, USA (12 Jun 1979).

The use of inductive storage systems has been studied as an attractive alternative to the more conventional capacitive energy storage systems to drive a cylindrical imploding plasma and produce X-rays for nuclear simulation. Preliminary experiments have been conducusing a 200 kJ, 4;mu;s capacitor bank and a 100 kJ, 1;mu;s capacitor bank to explore the basic performance of electrically exploded foil opening switches. Peak voltage and opening time have been chracterized as a function of quench media and capacitor bank risetime. Risetime and energetic efficiency of current transfer to inductive dummy loads have also been measured. These experimental results are contributing to conceptual designs for a 1.9 MJ capacitor driven inductive pulse shortening system.

25061 Safety grounding switches in large experiments; general considerations and the TEXT application. Wildi, P. (Univ of Tex, Austin). pp 355-358 of IEEE International Pulsed Power Conference. Guenther, A.H. (ed.). New York, NY; Inst. of Electrical and Electronics Engineers (1979).

From Pulsed power conference; Lubbock, TX, USA (12 Jun 1979).

The electrical installations of a large fusion experiment present many potential dangers such as residual charges on capacitor banks and cables, power rectifiers and other related power supplies, etc. The commonly used voltages of 1 to 20 kv lethal and the available power is sufficient to cause severe arc damage. Many experiments require frequent safe access with a minimum of time loss by both operating personnel and experiments. Safety must be automatic since the people involved are likely to be preoccupied with the experiments. The paper reviews some commonly employed practices and discusses the adequacy and safety of various grounding devices. The safety grounding scheme for the TEXT Tokamak is described. Specially designed switches, thecontact and operating mechanism, are shown and the integration of the switches in the overall control and safety system is discussed.

COOLING SYSTEMS

25062 (CONF-791102—168) **Stresses in liquid lithium modules in a tokamak blanket due to a changing poloidal magnetic field.** Walker, J.S.; Wells, W.M. (Illinois Univ., Urbana (USA); Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 5p. Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

For a fusion reactor blanket that contains molten lithium or lithium alloys, forces will arise when the magnetic field is changed and cause pressures in the lithium and stresses in the containment vessels. Previous analyses of this problem assume improperly that the conductive fluid is static. For the present analysis, the conductive liquid is contained in a thin-walled cylinder with a constant (toroidal) magnetic field perpendicular to the cylinder axis and with a time-varying (poloidal) magnetic field perpendicular to the toroidal field. The variables in the liquid are governed by the equations of magnetohydrodynamics and are coupled to the electric current and voltage in the cylinder wall, which are governed by Maxwell's equation and Ohm's law. Formulas are derived for the stresses in the cylinder wall caused by bending moment, torsion, shearing, and ring bending that result from the pressure and viscous shear force on the inside surface of the cylinder and from the electromagnetic body force in the cylinder wall. These formulas are used to calculate the module stresses for the design arrived at in the Oak Ridge National Laboratory (ORNL)/Westinghouse Demonstration (DEMO) Reactor Study.

HEATING AND FUELING SYSTEMS

REFER ALSO TO CITATION(S) 25052, 25075

25063 (CONF-791102—161) **Development of the ion source for PDX neutral beam injection.** Menon, M.M.; Tsai, C.C.; Gardner, W.L.; Barber, G.C.; Haselton, H.H.; Ponte, N.S.; Ryan, P.M.; Schechter, D.E.; Stirling, W.L.; Whealton, J.H. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 12p. Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

The paper describes the development of the ion source for neutral beam injection heating of PDX plasma. After a brief description of the plasma generator, the performance characteristics of the source, with different types of grids, are described. Based on test stand results it is concluded that at least two different versions of the source should be able to meet and even exceed the neutral power and energy requirements expected out of PDX injectors.

25064 (UCRL—84018) **Tandem mirror fusion fission hybrid studies.** Lee, J.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Feb 1980. Contract W-7405-ENG-48. 8p. (CONF-800446—2). NTIS, PC A02/MF A01.

From 2. international conference on emerging nuclear energy systems; Lausanne, Switzerland (8 Apr 1980).

Initial Tandem Mirror Hybrid Study predicts the ability to produce large amounts of fissile fuel (2 to 7 tonnes per year U233 from a 4000 MW plant) at a cost that adds less than 25% to the cost of power from an LWR.

25065 Coupling of electron-beam energy to an expanding thick-shelled target. Sweeney, M.A. (Sandia Laboratories, Albuquerque, New Mexico 87185). DE-AC04-76-DP00789. *J. Appl. Phys.;* **51**: No. 6, 3130-3133(Jun 1980).

The effect of spherical expansion on energy coupling to the pusher region of an ablatively driven net-energy-gain electron-beam target is discussed. The effect is evaluated numerically by using the density distribution in the coronal layers, obtained from hydrodynamic calculations, in a spherical-geometry Monte Carlo transport code. Much of the incident energy is absorbed in the low-density blowoff or is backscattered. Net energy gain targets will therefore require higher powers, and the optimum shell thickness may be less than predicted by previous calculations, which used deposition profiles for unexpanded material. Nevertheless, energy requirements are slightly lowered due to a decrease in bremsstrahlung heating of the pusher with target expansion.

TRITIUM PROCESSING, ENVIRONMENT AND SAFETY

REFER ALSO TO CITATION(S) 23798

25066 (LA-UR—79-2971) **Tritium Systems Test Assembly: objectives and design.** Anderson, J.L. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 3p. (CONF-800707—1). NTIS, PC A02/MF A01.

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

The principal program objectives for TSTA are: (1) to develop and demonstrate the fuel cycle for fusion power reactors; (2) to develop and test environmental and personnel protective systems; (3) to develop, test, and qualify equipment for tritium service; (4) to provide a final demonstration facility that could be directly copied for a D-T burning fusion machine; (5) to demonstrate long-term reliability of components; (6) to demonstrate long-term safe handling of tritium with no major releases or incidents; and (7) to investigate

and evaluate the response of the fuel cycle and environmental packages to normal, off-normal, and emergency situations.

25067 (LA-UR—80-1203) **Design and construction of the Tritium Systems Test Assembly.** Anderson, J.L. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 7p. (CONF-800427—6). NTIS, PC A02/MF A01.

From Tritium technology in fission, fusion, and isotopic application; Dayton, OH, USA (29 Apr 1980).

The objective of TSTA is to develop those aspects of tritium technology related to the fuel cycle for fusion power reactors and to develop the environmental and personnel safety systems required for such a tritium facility. The TSTA schedule calls for construction to be completed and the facility to be operational by the end of FY-1981. The project is now somewhat more than halfway through the design-construction phase and is currently on schedule for the 1981 operational milestone. In this paper the current status of the major subsystems will be discussed. The subsystems to be discussed include the: Vacuum Facility; Fuel Cleanup; Isotope Separation; Transfer Pump; Emergency Tritium Cleanup; Tritium Waste Treatment; Tritium Monitoring; Secondary Containment; and, the Master Data Acquisition and Control System.

25068 (LA-UR—80-1249) **Preliminary analysis of the safety and environmental impact of the Tritium Systems Test Assembly.** Carlson, R.V.; Jalbert, R.A. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 7p. (CONF-800427—7). NTIS, PC A02/MF A01.

From Tritium technology in fission, fusion, and isotopic application; Dayton, OH, USA (29 Apr 1980).

The Tritium Systems Test Assembly (TSTA) is a facility dedicated to the development of technologies associated with the D-T fuel cycle of future fusion reactors while demonstrating that TSTA can be operated safely with no significant losses to the environment. During the initial design stage of TSTA, a safety analysis was performed which investigated the effects of major subsystem component failure, the meteorology and seismicity of the site and their possible effect on the facility, and accident scenarios which result in tritium releases. Major releases of tritium to the environment are considered highly improbable since they require a compound failure of primary and secondary containment, along with either a breach of the building or a failure of the Emergency Tritium Cleanup system. Accidental releases caused by natural phenomena (earthquake, tornado, etc.) are considered highly improbable ($< 10^{-6}$/yr).

25069 (LA-UR—80-1273) **Fuel cleanup system for the tritium systems test assembly: design and experiments.** Kerr, E.C.; Bartlit, J.R.; Sherman, R.H. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 4p. (CONF-800427—8). Dep. NTIS, PC A02/MF A01.

From Tritium technology in fission, fusion, and isotopic application; Dayton, OH, USA (29 Apr 1980).

A major subsystem of the Tritium Systems Test Assembly is the Fuel Cleanup System (FCU) whose functons are to: (1) remove impurities in the form of argon and tritiated methane, water, and ammonia from the reactor exhaust stream and (2) recover tritium for reuse from the tritiated impurities. To do this, a hybrid cleanup system has been designed which utilizes and will test concurrently two differing technologies - one based on disposable, hot metal (U and Ti) getter beds and a second based on regenerable cryogenic asdorption beds followed by catalytic oxidation of impurities to DTO and stackable gases and freezout of the resultant DTO to recover essentially all tritium for reuse.

25070 **Accidental criticality of a fusion-fission hybrid blanket design.** Badham, V.C.; Kastenberg, W.E.; Pomraning, G.C.; Okrent, D. (Univ. of California, Los Angeles). *Nucl. Technol.;* **47**: No. 2, 221-233(Feb 1980).

Whenever a fissionable blanket is added to a controlled thermonuclear reactor, an investigation of the potential for accidental criticality is necessary to ensure the safety of this hybrid device. The neutronic effects of blanket meltdown and the ingress of steam into the blanket, studied for one such fusion-fission hybrid reactor, indicate that accidental criticality will be achieved only for very long blanket residence times or highly improvable accient sequences. Even though only one hybrid device was investigated, the results indicate that it is possible to design a reactor that will remain subcritical even under certain incredible circumstances.

25071 **Reduction in the toxicity of fission product wastes through transmutation with deuterium-tritium fusion neutrons.** Parish, T.A. (Texas A & M Univ., College, Station); Davidson, J.W. *Nucl. Technol.;* **47**: No. 2, 324-342(Feb 1980).

A waste management concept that employs irradiation of fission products in fusion reactor blankets is evaluated. The purpose of the irradiation is to reduce the toxicity of the material to be committed to geologic disposal. Target isotopes included ^{90}Sr, ^{137}Cs, ^{129}I, ^{99}Tc, ^{135}Cs, and ^{93}Zr. The n,γ), n,2n), (n,3n), (n,p), (nα), (n,d), (n,t), and (n,nα) reactions were all considered to contribute to the transmutation process. Extensive chains were employed in the depletion calculations performed to quantify the toxicity of the products. A sharp reduction in the short-term toxicity by a factor of 100 or more appears achievable, but should not be pursued unless the toxicity of the actinide wastes can also be substantially reduced.

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 24521, 24522, 24551, 24983

25072 **Method and apparatus for timing of laser beams in a multiple laser beam fusion system.** Eastman, J.M.; Miller, T.L. US Patent Application 030,044. [nd]. 32p.

The optical path lengths of a plurality of comparison laser beams directed to impinge upon a common target from different directions are compared to that of a master laser beam by using an optical heterodyne interferometric detection technique. The technique consists of frequency shifting the master laser beam and combining the master beam with a first one of the comparison laser beams to produce a time-varying heterodyne interference pattern which is detected by a photodetector to produce an AC electrical signal indicative of the difference in the optical path lengths of the two beams which were combined. The optical path length of this first comparison laser beam is adjusted to compensate for the detected difference in the optical path lengths of the two beams. The optical path lengths of all of the comparison laser beams are made equal to the optical path length of the master laser beam by repeating the optical path length adjustment process for each of the comparison laser beams. In this manner, the comparison laser beams are synchornized or timed to arrive at the target within $+- 1 \times 10^{-12}$ second of each other.

25073 (KMSF-U—970) **SYSLOG: an accounting and performance measurement system for RSX11M V3.2.** Downward, J.G. (KMS Fusion, Inc., Ann Arbor, MI (USA)). 1980. Contract AC08-78DP400300. 5p. (CONF-800414—4). NTIS, PC A02/MF A01.

From DECUS spring symposium; Chicago, IL, USA (22 Apr 1980).

A comprehensive system accounting package for RSX11M V3.2 offering users similar functionality to that available on RSX11M is presented. Although it was primarily implemented to monitor and collect system performance statistics, user by user statistics adequate for implementing chargeback accounting system are also acquired. System wide statistics include: CPU idle time, number of checkpoints, number of loader requests, number of QIO's, number of taks in and out of core, and pool usage parameters. Optionally, user selected tasks may be monitored for CPU time and QIO's. On a per user basis, CPU time, terminal connect time, QIO's, and number of pages spooled to printers, and a number of tasks run are accounted for. In addition, disk block accounting may be enabled on a per user basis. This package requires minor executive modifications and a SYSTEM generation to implement. However, it has been extensively field tested and has been found easy to implement by a large number of users. This software is available free through the RSX SIG and DECUS.

25074 (NRL-MR—4212) **Properties of ablatively accelerated targets.** Ripin, B.H.; Bodner, S.E.; Gold, S.H. (Naval Research Lab., Washington, DC (USA)). 16 May 1980. Contract ES-77-A-01-6021. 31p. NTIS, PC A03/MF A01.

Targets are ablatively accelerated to high velocity ($> 10^7$ cm/s) with good hydrodynamic efficiency ($\sim$ 20%) using low-irradiance (10^{13} to 10^{14}W/cm^2) long (3 to 4 ns) Nd-laser pulses. Detailed properties of the interaction and acceleration as well as comments upon the suitability of this approach to the laser fusion application are presented. Results of unique double-target experiments are also included.

25075 (SAND—80-0402) **Intense pulsed ion beams for fusion applications.** Humphries, S. Jr. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1980. Contract EY-76-C-04-0789. 220p. Dep. NTIS, PC A10/MF A01.

The subject of this review paper is the field of intense pulsed ion beam generation and the potential application of the beams to fusion research. Considerable progress has been made over the past six years. The ion injectors discussed utilize the introduction of electrons into vacuum acceleration gaps in conjunction with high voltage pulsed power technology to achieve high output current. Power levels from injectors exceeding 1000 MW/cm^2 have been obtained for pulse lengths on the order of 10^{-7} sec. The first part of the paper treats the physics and technology of intense ion beams. The second part is devoted to applications of intense ion beams in fusion research. A number of potential uses in magnetic confinement systems have been proposed. (MOW)

25076 (UCID—18588) **Polarizer reflectivity variations.** Ozarski, R.G.; Prior, J. (California Univ., Livermore (USA). Lawrence

Livermore Lab.). 22 Feb 1980. Contract W-7405-ENG-48. 14p. Dep. NTIS, PC A02/MF A01.

On Shiva the beam energy along the chain is monitored using available reflections and/or transmission through beam steering, splitting, and polarizing optics without the intrusion of any additional glass for diagnostics. On the preamp table the diagnostic signal is obtained from the signal transmitted through turning mirrors. At the input of each chain the signal is obtained from the transmission through one of the mirrors used for the chain input alignment sensor (CHIP). At the chain output the transmission through the final turning mirror is used. These diagnostics have proved stable and reliable. However, one of the prime diagnostic locations is at the output of the beta rod. The energy at this location is measured by collecting small reflections from the last polarizer surface of the beta Pockels cell polarizer package. Unfortunately, calibration of this diagnostic has varied randomly, seldom remaining stable for a week or more. The cause of this fluctuation has been investigated for the past year and it has been discovered that polarizer reflectivity varies with humidity. This report will deal with the possible causes that were investigated, the evidence that humidity is causing the variation, and the associated mechanism.

25077 (UCRL—81919) **Space-time energy concentration and the design of DT fusion micro-explosions.** Sahlin, H.L.; Brandenburg, J.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1980. Contract W-7405-ENG-48. 16p. (CONF-781247—8). NTIS, PC A02/MF A01.

From 2. international conference on energy storage, compression and switching; Venice, Italy (5 Dec 1978).

As part of the effort to employ a plasma focus as a driver for fusion micro-explosions, many target concepts were explored and extensive imposion calculations have been carried out. Some of the basic principles of micro-explosion design are presented.

25078 (UWFPP—7) **Evaluation of impact fusion concepts. Final report, 1 June 1979-1 December 1979.** Ribe, F.L.; Peaslee, A.T. Jr. (Washington Univ., Seattle (USA); Los Alamos Scientific Lab., NM (USA)). 30 Jan 1980. Contract EY-76-S-06-2225-046. 64p. NTIS, PC A04/MF A01.

This final joint report of the University of Washington and Los Alamos Scientific Laboratory programs on the evaluation of impact fusion concepts summarizes the conclusions and recommendations based on a critical review of the Impact Fusion Workshop held at the National Security and Resources Study Center at Los Alamos, New Mexico, on July 10-13, 1979, by joint UW/LASL working groups and on independent research conducted at the University of Washington.

25079 **X-ray microradiographs of laser fusion targets: improved image analysis techniques.** Whitman, R.L.; Day, R.H. (University of California, Los Alamos Scientific Laboratory, P.O. Box 1663, Los Alamos, New Mexico 87545). W-7405-ENG-36. *Appl. Opt.;* **19**: No. 10, 1718-1722(15 May 1980).

Improved techniques for analyzing x-ray microradiographic images of laser fusion targets are described. A fast Fourier transform (FFT) technique is used to detect efficiently inner—outer wall nonconcentricities of +- 95 A in hollow glass shells having a mean wall thickness of 1 μm. An improved technique for detecting and quantifying local wall-thickness variations is described. These results are compared with previous sensitivities.

25080 **Three-dimensional reconstruction of the x-ray emission in laser imploded targets.** Minerbo, G.N.; Sanderson, J.G.; van Hulsteyn, D.B.; Lee, P. (University of California, Los Alamos Scientific Laboratory, P.O. Box 1663, Los Alamos, New Mexico 87545). *Appl. Opt.;* **19**: No. 10, 1723-1728(15 May 1980).

To investigate the uniformity of compression of spherical targets irradiated with high-energy CO_2 lasers, an array of pinhole cameras has been set up to obtain 2-D views from four different directions. To reconstruct the 3-D source we have devised a computer code based on a maximum entropy algorithm. With synthetic input data the code gives acceptable reconstructions provided the source is smooth and has a simple shape. We present a set of serial slices through the reconstructed x-ray emission distribution in a glass microsphere imploded with the LASL two-beam laser.

25081 **Propagation of intense ion beams in straight and tapered z-discharge plasma channels.** Ottinger, P.F.; Mosher, D.; Goldstein, S.A. (Naval Research Laboratory, Washington, D. C. 20375). SANDIA LAB. CONTRACT 07-9062. *Phys. Fluids;* **23**: No. 5, 909-920(May 1980).

A preformed z-discharge plasma channel can be used to transport focused ion beams appropriate for a pellet fusion device. During transport, the beam can be compressed axially by time-of-fight bunching when appropriate ion accelerating voltage waveforms are employed. Single-particle orbits in such channels are expressible in terms of simple harmonic functions for small ion injection angles. In this work, orbit analysis is used to investigate how nonuniformities or tapering of the channel and electric fields present in the channel affect radial beam confinement and power multiplication by bunching.

25082 **Laser-plasma interaction and ablative acceleration of thin foils at 10^{12}—10^{15} W/cm².** Ripin, B.H.; Decoste, R.; Obenschain, S.P.; Bodner, S.E.; McLean, E.A.; Young, F.C.; Whitlock, R.R.; Armstrong, C.M.; Grun, J.; Stamper, J.A.; Gold, S.H.; Nagel, D.J.; Lehmberg, R.H.; McMahon, J.M. (Naval Research Laboratory, Washington, D.C. 20375). *Phys. Fluids;* **23**: No. 5, 1012-1030(May 1980).

The interaction physics and hydrodynamic motion of thin-foil targets irradiated by long, low-flux Nd-laser pulses (3 nsec, 10^{12}—10^{15} W/cm²) are studied experimentally and compared with theoretical models. Laser light absorption is high (80%—90%) and thin-foil targets are accelerated up to 10^7 cm/sec with good (20%) hydrodynamic efficiency in the 10^{12}—10^{13} W/cm² range. These results agree with a simple rocket ablation model. Details of thermal heat flow, both axially (related to ablation depth) and laterally (related to beam uniformity requirements), are also presented.

25083 **Pellet ad pellet-blanket neutronics and photonics for electron beam fusion.** Ragheb, M.M.H. (Univ. of Illinois, Urbana); Moses, G.A.; Maynard, C.W. *Nucl. Technol.;* **48**: No. 1, 16-33(Apr 1980).

Pellet and coupled pellet-blanket time-integrated neutronics and photonics calculations are reported for a representative low-gain (25), low-compression (deuterium-tritium core pr = 9.4 kg/m²) pellet design for an electron beam fusion reactor. Tungsten, lead, and natural uranium are compared as pusher-tamper materials. In the three cases, neutron balances show that neutron multiplication in the pellet compensates for the energy losses and spectral softening due to neutron interactions. Fissile breeding cannot be achieved in the natural uranium case, since the fission reaction predominates. Substantive additonal energy can be obtained (~ 5.5 MeV/source neutron) in the pellet if natural uranium is used as the tamper material. Neutron and gamma spectra from the pellet microexplosions are given.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

REFER ALSO TO CITATION(S) 24416, 24534, 25000

25084 (CONF-791058—74) **Integral experiments for fusion reactor design: analysis.** Santoro, R.T.; Alsmiller, R.G. Jr.; Barnes, J.M.; Oblow, E.M. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 3p. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

Integral experiments that measure the energy spectra of neutrons and gamma rays due to the transport of ~ 14 MeV D-T neutrons through laminated SS-304 and borated polyethylene shield assemblies have been performed. Measured and calculated energy spectra and integrated flux distributions are compared for a typical shield assembly as a function of detector location.

25085 (CONF-791058—75) **Shielding of fusion reactors.** Alsmiller, R.G. Jr. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 7p. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

The blanket and shield assemblies of fusion reactors will contain a significant number of very sizable penetrations (neutral beam injection ducts, pumping ports, etc.). The combination of high-energy neutrons and large penetrations will introduce severe design problems that are quite different from those encountered previously. Fusion reactors with their penetrations are very complex geometric structures and in calculating nuclear effects (heating, activation, etc.) tradeoffs must be made between computing efficiency and the accuracy in the geometric modeling. The types of problems that arise due to large penetrations will be illustrated by the calculations that have been carried out to aid in the design of the shielding for the neutral beam injectors of the Tokamak Fusion Test Reactor being built at Princeton University.

25086 (CONF-791102—165) **Calorimeter for pulsed energy sources.** Pearce, J.W.; Edmonds, P.H. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 3p. Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

A common problem in plasma physics experiments is the measurement of the energy deposited on a water-cooled plate by a pulsed energy source. Examples of this are neutral-beam-line defining plate and targets and tokamak water-cooled limiters. One method of measuring this energy is to integrate the product of the temperature rise (ΔT) and the flow rate (F) of the coolant over the interval between the pulses. The two input parameters ΔT and F are derived from a differential thermopile and a turbine flow meter,

respectively. A simple digital readout circuit displays the deposited energy in a light-emitting diode display. The circuit uses a commercially available, dual-slope analog-to-digital converter (ADC) in a novel configuration that multiplies ΔT and F directly. Calibration of the readout circuit is quick and simple, and short-term accuracies of 5% are easily obtained. Over longer periods the accuracy becomes degraded, primarily by thermal drifts in the thermopile amplifier and in the thermopile connections and the wiring. This offset must be compensated for by a simple adjustment before each experimental run. This readout circuit has been used successfully on the Impurity Study Experiment (ISX-B) neutral beam lines and is most convenient for deposited energy measurements in applications in which computerized data acquisition is not available.

25087 (CONF-791102—171) **Direct cryosorption pumping of an energetic hydrogen ion beam.** Schwenterly, S.W.; Ryan, P.M.; Tsai, C.C. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 5p. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

Cryosorption pumps (CSP) are a prime candidate for the pumping of helium and deuterium-tritium (D-T) in tokamak divertor systems and may also see service in neutral beam injectors. However, the ability of a CSP to take high energy ions escaping from a plasma or neutral beam has not previously been demonstrated. In this study we arranged a 10-cm ion source of the type used in the Oak Ridge Tokamak (ORMAK) to inject a beam of ions directly into the inlet of a CSP. The pump contained two chevron baffles at 100K and 15K as well as a 15K cryosorption surface covered with a type 5A molecular sieve. The cryosurfaces were cooled by a closed-cycle helium refrigerator. For hydrogen ion pulses up to 11.5-keV energy and 1.3-A current, the pressure maintained during the pulse was only a few percent higher than that maintained with an equal flow of cold neutral gas. Pulse lengths of 100-300 ms were used. Calorimetric measurements showed that 40-60% of the I-V power was incident on the pump inlet. Cool-down and regeneration behavior of the pump will also be discussed.

25088 (CONF-800455—8) **Initial testing of coated limiters in ISX-B.** Langley, R.A.; Emerson, L.C.; Whitley, J.B.; Mullendore, A.W. (Oak Ridge National Lab., TN (USA); Sandia Labs., Albuquerque, NM (USA)). 1980. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on plasma surface interactions in controlled fusion devices; Garmisch, F.R. Germany (21 Apr 1980).

Low-Z coatings on graphite substrates have been developed for testing as limiters in the Impurity Study Experiment (ISX-B) tokamak. Laboratory and tokamak testings have been accomplished. The laboratory tests included thermal shock experiments by means of pulsed e-beam irradiation, arcing experiments, and hydrogen and xenon ion erosion experiments. The tokamak testing consisted of ohmically heated plasma exposures with energy depositions up to 10 kJ/discharge on the limiters. The coatings, applied by chemical vapor deposition, consisted of TiB_2 and TiC deposited on POCO graphite substrates.

25089 (DOE/ET—0065/8) **Damage analysis and fundamental studies. Quarterly progress report, October-December 1979.** (Department of Energy, Washington, DC (USA). Office of Fusion Energy). Feb 1980. 172p. Dep. NTIS, PC A08/MF A01.

Progress on each of the following topics is outlined: (1) rotating target neutron source, (2) fusion materials irradiation test facility, (3) environmental characterization, (4) damage production, and (5) damage microstructure evolution and mechanical behavior. (MOW)

25090 (HEDL-SA—1889-FP) **Deposition and control of ^{7}Be in liquid lithium.** Bechtold, R.A. (Hanford Engineering Development Lab., Richland, WA (USA)). 1980. Contract AC14-76FF02170. 8p. (CONF-800401—12). Dep. NTIS, PC A02/MF A01.

From 2. international conference of liquid metal technology for energy systems; Richland, WA, USA (20 Apr 1980).

Preferential beryllium-7 deposition has been found in the higher temperature region of non-isothermal flowing lithium between 270°C to 200°C. Various methods for controlling ^{7}Be distribution for application to the Fusion Materials Irradiation Test (FMIT) facility are examined. Flushing a loop with 425°C lithium decreased ^{7}Be activity on pipe walls by 60 to 80%. Yttrium has been found to be more effective than the other materials tested for removal of ^{7}Be from lithium. Preliminary results on diffusion traps indicate effectiveness for ^{7}Be removal also.

25091 (PPPL—1666) **Review of the wall problem and conditioning techniques for tokamaks.** Dylla, H.F. (Princeton Univ., NJ (USA). Plasma Physics Lab.). May 1980. Contract AC02-76CH03073. 40p. NTIS, PC A03/MF A01.

A variety of conditioning techniques have been applied to tokamaks to control low Z impurities originating from vacuum vessel surface contaminants and to modify the working gas recycling properties. After chemical or physical treatment of the vacuum vessel hardware, in-situ vacuum vessel treatments are usually applied, including: (1) vacuum baking; (2) discharge cleaning; and (3) gettering. As the magnetic fusion program moves to the next generation of large test reactors, the implementation of any of the above techniques becomes a costly procedure. It is therefore prudent to understand the mechanisms and physical-chemical effects of a particular conditioning procedure and maximize the efficiency. A review is given of the present understanding of the physical mechanisms, the resulting surface effects, and benefits to plasma performance of the various conditioning procedures. Particular attention is given to the application of hydrogen glow discharge cleaning and the use of titanium gettering as conditioning procedures.

25092 (SAND—79-2105C) **Testing of low Z coated limiters in tokamak fusion devices.** Whitely, J.B.; Mullendore, A.W.; Langley, R.A. (Sandia Labs., Albuquerque, NM (USA); Oak Ridge National Lab., TN (USA)). 1980. Contract EY-76-C-04-0789. 20p. (CONF-800439—3). NTIS, PC A02/MF A01.

From International conference on metallurgical coatings; San Diego, CA, USA (21 Apr 1980).

Extensive testing on a laboratory scale has been used to select those coatings most suitable for this environment. From this testing which included pulsed electron beam heating, low energy ion bombardment and arcing, chemical vapor deposited coating of TiB_2 and TiC on Poco graphite substrates have been selected and tested as limiters in ISX. Both limiter materials gave clean, stable, reproducible tokamak discharges the first day of operation. After one weeks exposure, the TiC limiter showed only superficial damage with no coating failure. The TiB_2 limiter had some small areas of coating failure. TiC coated graphite limiters have also been briefly tested in the tokamaks Alcator and PDX with favorable results.

25093 (SAND—79-2409C) **Development and laboratory testing of low Z refractory coatings for fusion reactor limiters.** Mullendore, A.W.; Whitley, J.B.; Mattox, D.M. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 19p. (CONF-800455—6). NTIS, PC A02/MF A01.

From 4. international conference on plasma surface interactions in controlled fusion devices; Garmisch, F.R. Germany (21 Apr 1980).

A materials development program for low Z ($Z < 24$) coated tokamak limiters is described. A variety of refractory coatings applied by chemical vapor deposition, plasma spraying and chemical conversion to graphite and copper substrates have been evaluated. The results of laboratory testing for low energy hydrogen ion erosion, arc erosion and thermal fatigue by pulsed electron beam heating are reported. The 250 V hydrogen ion erosion data, analysed in terms of the effect of plasma radiation losses from resultant contaminants, indicates near equivalence of the very low Z (B and B_4C e.g.) and the moderate Z (e.g., TiB_2) coatings. Thermal fatigue testing has identified several candidate materials which can survive 1000, 3 kJ /cm^2 pulses of electron beam heating. The development of prototype limiters of TiB_2, TiC and B coated graphite for testing in the ORNL ISX-B tokamak is described.

25094 **Fifteen-centimeter-diameter UHV transfer system for remote plasma-wall interaction experiments.** Clausing, R.E.; Emerson, L.C.; Heatherly, L.; Domm, T.C.; Simpkins, J.E.; Langley, R.A. (Metals and Ceramics Division Oak Ridge National Laboratory Oak Ridge, Tennessee 37830). W-7405-ENG-26. *J. Vac. Sci. Technol.;* **17**: No. 3, 709-713(May 1980).

A versatile UHV apparatus is described which permits large (up to 10 x 10 cm) sample arrays or entire experiments to be inserted from air into an operating tokamak. This can be accomplished without perturbing the tokamak vacuum. Samples or experiments may be exposed in the tokamak for studies of plasma-wall interactions and removed at any time without requiring tokamak shutdown. Samples or experiments may be accurately positioned in the region between the vacuum wall and the plasma limiter remotely. The apparatus provides up to 20 electrical connections for thermocouples, heaters, and signal leads. It also provides linear and rotary mechanical motion for operating experiments sychronized to tokamak discharges. Experiments or samples may be prepared off site and loaded into the transfer system under vacuum. A surface analysis station integral with the transfer system permits individual sample preparation, characterization, and analysis before and after plasma exposures.

25095 **Effect of container preparation on the growth of protium and methane impurities into tritium gas.** Gill, J.T. (Mound Facility Miamisburg, Ohio 45342). DE-ACO4-76-DP00053. *J. Vac. Sci. Technol.;* **17**: No. 2, 645-654(Mar 1980).

Ten vessels, candidates for the unperturbed storage of analytical calibration gases containing tritium, were investigated. Contamination of 99.7% tritium gas at STP by each container over one year was a function of vessel material and surface preparation. Cylinders of aluminum and stainless steel (SS) could restrict protium ingrowth

better than could hydroxyl-rich borosilicate glass. Canister surfaces with the least surface area also allowed the least protium and methane ingrowth: slower exchange of hydrogen isotopes between material and gas, and less occlusion of organic contaminants are likely causes. Protium ingrowth from bulk metal was successfully inhibited by the thin surface oxide or deformed near-subsurface structure present on dry-paper polished SS; gold ion plating such a vessel was no more effective in minimizing protium. Methane could be nearly excluded from tritium by careful cleaning of container material. Borosilicate glass and dry-paper polished SS appeared more effectively cleaned by solvent washing than did electropolished SS or burnished aluminum. Electrocleaning or oxygen discharging procedures removed hydrocarbons effectively, but led to high protium injection to metal. Careful handling of treated container parts is important. Three to four monolayers of adsorbed organics on a surface can cause observable protium and methane impurity in tritium gas.

25096 Design and operational characteristics of the cryopump high-vacuum system for the 25 000-l target chamber of the Helios Laser Facility. Wilson, N.G.; Watts, K.N. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). W-7405-ENG-36. *J. Vac. Sci. Technol.;* 17: No. 1, 270-273(Jan 1980).

A vacuum system utilizing two 25 000 l/s (H_2O) two-stage (20 and 70 K) helium refrigerator (cold gas) cryopumps and a 1500 l/s turbomolecular pump has been provided for a 25,000: l-volume stainless steel chamber as a part of the Helios Laser Facility. Design goals for the performance of the vacuum system are to produce a chamber pressure of less than 1.33×10^{-4} Pa after two hours pumping from atmospheric pressure. Details of the vacuum system configuration, and typical operating conditions are described. Observations made during operation indicate the cryopumps utilized initially produce expected pumping performance followed by variable performance (pumping speed and ultimate pressure) depending upon pumping history. The turbomolecular pump utilized has demonstrated reproducible pump speed and ultimate pressure. Both pumps produce some vibration which can cause interference with critical components in the target chamber; vibration damping/attenuation has been successfully employed for the turbomolecular pump with similar techniques being studied for use with the cryopumps. Reliability of the machines utilized has been excellent with only routine maintenance required in the first year of operation. Considerable instability in ionization gauges (Bayard—Alpert type) has been experienced where the expected gauge sensitivity of 10 per Torr has been observed to vary from 7.5 to >11.

25097 Glow discharge conditioning of the PDX vacuum vessel. Dylla, H.F.; Cohen, S.A.; Rossnagel, S.M.; McCracken, G.M.; Staib, P. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). EY-76-C-02-3073. *J. Vac. Sci. Technol.;* 17: No. 1, 286-290(Jan 1980).

A glow discharge technique has been developed and applied to the conditioning of the large (38 m^3) Poloidal Divertor Experiment (PDX) vacuum vessel. The discharge parameters and working gas (H_2) were chosen to maximize C and O removal and minimize metal sputtering. The glow discharge was produced by biasing one or two internal anodes at 400 V to sustain a discharge current of 2—4 A per anode. Purified H_2 at a pressure of 3×10^{-2} Torr was flowed through PDX at ~10 Torr l/s. The effectiveness of the glow discharge conditioning was monitored by measuring impurity gas (CH_4, C_2H_4, and CO) exhaust rates by mass spectrometry and C and O surface removal rates by in situ AES and XPS. Initial glow discharge operation was accompanied by frequent arcing which subsequently decreased with time. Low Z/sub eff/ (≃2) high-power discharges were obtained in PDX after 120 h of glow discharge treatment, during which more than 100 equivalent monolayers of C and O were removed from the vessel.

25098 X-ray photoelectron spectroscopy (XPS) studies of oxygen and carbon bonding to tokamak walls. Staib, P.; Dylla, H.F.; Rossnagel, S.M. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). EY-76-C-02-3073. *J. Vac. Sci. Technol.;* 17: No. 1, 291-293(Jan 1980).

The binding energies of surface atoms of stainless steel samples exposed to hydrogen plasma discharges in PDX are measured using x-ray photoelectron spectroscopy. After glow discharge conditioning the O/sub 1s/ line is completely shifted to a higher binding energy which is an indication of the formation of hydroxides. The Fe/sub 2p/ lines show a partial reduction of iron. After high power discharges, the oxygen concentration increases and the binding energy of the deposited O atoms corresponds to a metallic oxide. The deposited limiter material Ti is also completely oxidized. For both kinds of discharges the binding energies of Cr/sub 2p/ and C/sub 1s/ remain essentially unmodified.

25099 Transient getter scheme for the Tokamak Fusion Test Reactor. Cecchi, J.L.; Cohen, S.A.; Sredniawski, J.J. (Princeton University, Plasma Physics Laboratory, Princeton, New Jersey 08544). EY-76-C-02-3073. *J. Vac. Sci. Technol.;* 17: No. 1, 294-297(Jan 1980).

The ability of the Tokamak Fusion Test Reactor (TFTR) to attain the largest fusion power gain depends critically on minimizing plasma contamination and controlling the densities of the reacting deuterium and tritium. Experiments on a number of tokamaks have demonstrated that gettering over an appreciable surface area (> or = 10%) of the vacuum vessel greatly facilitates both of these objectives. One particular problem in implementing a surface pumping system in TFTR, however, is a restriction on the maximum allowable tritium content of the getter. This restriction could require regeneration of the absorbed tritium after as few as 50 machine pulses. We have developed a scheme utilizing SAES Zr/Al getter modules which obviates the need for such frequent interruptions of machine operation by taking advantage of the pulsed operation of TFTR. With the Zr/Al getter at temperatures between 500°—600°C it is possible to achieve a quasisteady state in the tritium loading where the quantity of tritium desorbed between pulses is equal to the quantity which is absorbed during a pulse. Since frequent thermal cycling is not required, this scheme also reduces the possibility of Zr/Al getter material fatigue.

25100 Thermal responses of first wall limiters in the Tokamak Fusion Test Reactor. Budny, R. (Princeton University, Princeton, New Jersey 08544). EY-76-C-02-3073. *J. Vac. Sci. Technol.;* 17: No. 1, 298-300(Jan 1980).

A model was used for the heat flux to estimate the thermal responses and the sublimation rates of several first wall limiters proposed for the Tokamak Fusion Test Reactor. The critical parameter is the thickness of the scrape-off layer, or outer skin of the plasma. The thinner this is, the hotter the limiter will become after repeated discharges. The minimum tolerable thickness is about 0.5 cm for copper or graphite tiles over Nitronic 33 steel backing plates. For thicknesses less than this the steel will be too hot; the sublimation rates of most of the proposed first wall coatings for the tiles are sufficiently low to not contaminate the plasma.

25101 Thermal desorption measurements of hydrogen—isotope retention in the Alcator-A tokamak. Razdow, A.M.; Marmar, E.S.; Cohen, S.A.; Dylla, H.F. (Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). DE-AC02-78ET51013.A002; EY-76-C-02-3073. *J. Vac. Sci. Technol.;* 17: No. 1, 306-309(Jan 1980).

Results are presented for deuterium retention measurements in type 304 stainless steel exposed in the edge plasma of the Alcator-A tokamak. Stainless steel samples, at 300 K, with surface conditions characterized by Auger electron spectroscopy, were introduced into the limiter shadow region for exposure to deuterium plasmas, and then withdrawn into an appended UHV chamber for thermal desorption measurements. For unoxidized samples exposed at the vacuum vessel wall radius, 1×10^{15} D cm^{-2} was retained after exposure to high density (n-bar/sub e/=3×10^{14} cm^{-3}) discharges. Exposure to consecutive series of N discharges produced retention proportional to N/sup 1/2/.

GENERAL AND MISCELLANEOUS

MANAGEMENT

REFER ALSO TO CITATION(S) 24173, 24332, 24333

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 23564, 23572, 24632, 24633

25102 Concurrent software system design supported by SARA at the age of one. Campos, I.M.; Estrin, G. Los Angeles, CA; University of California ([nd]). 13p.

A multilevel modeling method suitable for the design of concurrent hardware or software systems is presented. The methodology is requirement driven and uses tools incorporated in a programming system called SARA (Systems ARchitect's Apprentice). Both top-down refinement and bottom-up abstraction are supported. The design of an asynchronous sender-receiver illustrates the key steps in going smoothly from programing in the large to programing in the small or actual code. The same methodology can be used to design hardware systems by applying different pragmatics from those proposed for software systems. SARA consists of a set of interactive tools implemented both at UCLA and also on the MIT-Multics system. Although SARA continues in long-term development, completed design tools are accessible for experimentation by authorized users at either location via the ARPANET. 9 figures, 2 tables.

25103 **SARA aided design of software for concurrent systems.** Campos, I.M.; Estrin, G. Los Angeles, CA; University of California ([nd]). 12p.

A set of tools to support a structured multilevel design procedure for software or hardware development is described. This interactive computer-aided system, called SARA (Systems ARchitect's Apprentice), provides languages to help a designer form useful abstractions that can be manipulated and tested in a disciplined way. SARA supports both a bottom-up (abstraction) procedure and a top-down partitioning (refinement) procedure. The procedures are requirement driven. Models are created with a small number of primitives. Explicit flow behavior can be expressed by control nodes. This paper concentrates on the SARA methodology as applied to software. The central problem is the set of tools and procedures to be brought to bear on building possibly concurrent software systems that reliably carry out the designer's intent. The reader is taken through the key steps of two example designs, a synchronized sender-receiver and a fast fourier transformer. Following an informal statement of need, the design universe is partitioned into the system to be designed and its environment. An initial behavioral model fixes all assumptions under which the design is to proceed. Requirements establish evaluation criteria for the system. After top-down levels of designer-created behavior, there is a final composition step to produce PL/1 code. 10 figures. (RWR)

25104 (BNL—27513) **Generation of approximating distributions through the method of stages.** Noetzel, A.S. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 4p. (CONF-800364—1). Dep. NTIS, PC A02/MF A01.

From Conference on information sciences and systems; Princeton, NJ, USA (26 Mar 1980).

The method of stages is a technique for representing an arbitrary continuous probability distribution as a series of states (or stages), each of which has an exponentially distributed hold time. Through the use of the method of stages, a discrete-event stochastic simulation may be reduced to a Markov chain. Two techniques for generating the probability distribution function required by the method of stages are discussed. The first, Prony's method, requires evenly spaced samples of the probability functions to be matched. The second method is an iterative algorithm that uses every set of sample values of the required distribution, and, if the mean of the distribution is given, matches the mean exactly. 1 figures.

25105 (BNL—27665) **Overview of image reconstruction.** Marr, R.B. (Brookhaven National Lab., Upton, NY (USA)). Apr 1980. Contract EY-76-C-02-0016. 59p. (CONF-7910159—1). NTIS, PC A04/MF A01.

From International symposium on ill-posed problems: theory and practice; Newark, DE, USA (2 Oct 1979).

Image reconstruction (or computerized tomography, etc.) is any process whereby a function, f, on R/sup n/ is estimated from empirical data pertaining to its integrals, $\int f(x)\,dx$, for some collection of hyperplanes of dimension $k < n$. The paper begins with background information on how image reconstruction problems have arisen in practice, and describes some of the application areas of past or current interest; these include radioastronomy, optics, radiology and nuclear medicine, electron microscopy, acoustical imaging, geophysical tomography, nondestructive testing, and NMR zeugmatography. Then the various reconstruction algorithms are discussed in five classes: summation, or simple back-projection; convolution, or filtered back-projection; Fourier and other functional transforms; orthogonal function series expansion; and iterative methods. Certain more technical mathematical aspects of image reconstruction are considered from the standpoint of uniqueness, consistency, and stability of solution. The paper concludes by presenting certain open problems. 73 references. (RWR)

25106 (CONF-790431—(Summ.)) **AESOP XX: summary of proceedings.** (Department of Energy, Washington, DC (USA). Office of Computer Services and Telecommunications Management). Mar 1980. 50p. NTIS, PC A03/MF A01.

From 20. AESOP conference; Gatlinburg, TN, USA (24 Apr 1979).

The 20th meeting of the Association for Energy Systems, Operations, and Programming (AESOP) was held in Gatlinburg, Tennessee, on April 24 to 26, 1979. Representatives of DOE Headquarters discussed the effects that new security and privacy regulations will have on automatic data processing operations. The status and future possibilities of the Business Management Information System (BMIS) were also discussed. Then representatives of various DOE offices and contractors presented reports on various topics. This report contains two-page summaries of the papers presented at the meeting. Session topics and titles of papers were as follows: Washington report (New ADP issues; BMIS: the Business Management Information System; Nuclear weapons and the computer); Improving the productivity of the computing analyst/programer (What productivity improvement tools are available; Rocky Flats experience with SDM/70; Albuquerque Operations Office experience with SDM/70; Planning and project management; Minicomputer standards and programer productivity; MRC productivity gains through applications development tools); User viewpoints and expectations of data processing (User perspectives on computer applications; User viewpoints on environmental studies; Planning and implementing a procurement system; Two sides of the DP coin); Data base management (Use of data base systems within DOE; Future trends in data base hardware; Future trends in data base software; Toward automating the data base design process); and Management discussions. Complete versions of three of the papers have already been cited in ERA. These can be located by reference to the entry CONF-790431— in the Report Number Index. (RWR)

25107 (COO—4596-1(Vol.3)) **Radian DART microcomputer system hardware documentation operation system description. DART II documentation.** (Radian Corp., Austin, TX (USA)). 23 May 1979. Contract EY-77-C-02-4596. 131p. Dep. NTIS, PC A07/MF A01.

This operator's manual for the DART II Data Acquisition, Reduction, and Transmission system is divided into the following sections: system capabilities and configuration; ways in which the microprocessor-based central processing unit communicates with the memory and peripheral devices; theory of operation for the system components; and a section of reference data including schematic diagrams, cable lists, device specification sheets and other detailed information. (GHT)

25108 (DOE/EV/02874—64) **Sample size for logistic regression with small response probability. Technical report No. 33.** Whittemore, A.S. (Stanford Univ., CA (USA). Dept. of Statistics). Mar 1980. Contract AC02-76EV02874. 25p. NTIS, PC A02/MF A01.

The Fisher information matrix for the estimated parameters in a multiple logistic regression can be approximated by the augmented Hessian matrix of the moment generating function for the covariates. The approximation is valid when the probability of response is small. With its use one can obtain a simple closed-form estimate of the asymptotic covariance matrix of the maximum-likelihood parameter estimates, and thus approximate sample sizes needed to test hypotheses about the parameters. The method is developed for selected distributions of a single covariate, and for a class of exponential-type distributions of several covariates. It is illustrated with an example concerning risk factors for coronary heart disease. 2 figures, 2 tables.

25109 (EGG—2015) **Packet switching.** Derr, K.W. (EG and G Idaho, Inc., Idaho Falls (USA)). Mar 1980. Contract EY-76-C-07-1570. 83p. NTIS, PC A05/MF A01.

This report assembles information on the theories of store-and-forward packet switching, and surveys existing operational packet-switching networks. It includes a comparison of the types of packet switching; packet-switching techniques; procedures for controlling errors, flow, and congestion; and protocol layers used in packet-switching networks. 132 references, 25 figures, 2 tables.

25110 (KAPL—4134) **High-order curved finite elements.** Wachspress, E.L. (Knolls Atomic Power Lab., Schenectady, NY (USA)). Mar 1980. Contract AC12-76SN00052. 23p. (CONF-800537—1). Dep. NTIS, PC A02/MF A01.

From Symposium on finite elements; Storrs, CT, USA (2 May 1980).

Recent finite element analysis of adaptive refinement has focused attention on high-order approximation within elements. High-order approximation may be attained over curved elements with either rational basis functions expressed directly in the global coordinates or with a particular class of isoparametric basis functions. Theory for construction of high-order rational bases yields modifications to the blending method for a special class of elements in order to achieve higher order approximation within these elements. 9 figures.

25111 (ORNL/TM—7265) **Note on the robustness of Dixon's ratio test in small samples.** Chernick, M.R. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

Dixon's ratio test is a simple procedure for testing for outliers in statistical data that has been particularly effective when the data come from an underlying normal distribution. The critical values for the normal case are compared to the uniform, exponential, and Cauchy cases with samples of size three, four, and five. When the sample size is three, Dixon's ratio is fairly robust to various departures from normality (i.e., skewness and kurtosis). For symmetric distributions that are not heavy tailed, it appears to be robust in larger sample sizes than just three. However, for the Cauchy case and for very skewed distributions such as the exponential, the critical values are very different even when the sample size is only four. The fact that Dixon's ratio is robust in samples of size three is a valuable practical result, since many times the underlying distribution is not well understood. In a data validation study of a monthly power plant report Dixon's test was applied by grouping the data in sets of three. That application is discussed in this paper. 1 figure, 2 tables.

25112 (SAND—80-0438C) **Which grids are Hamiltonian?.** Hedetniemi, S.M.; Hedetniemi, S.T.; Slater, P.J. (Oregon Univ., Eugene (USA). Dept. of Computer and Information Science; National Science Foundation, Washington, DC (USA); Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 15p. (CONF-800367—1). Dep. NTIS, PC A02/MF A01.

From 11. SE conference on combinatories, graph theory, and computing; Boca Raton, FL, USA (3 Mar 1980).

A complete grid G/sub m,n/ is a graph having m x n pertices that are connected to form a rectangular lattice in the plane, i.e., all edges of G/sub m,n/ connect vertices along horizontal or vertical lines. A grid is a subgraph of a complete grid. As an illustration, complete grids describe the basic pattern of streets in most cities. This paper examines the existence of Hamiltonian cycles in complete grids and complete grids with one or two vertices removed. It is determined for most values of m,n $\geq$ 1, which grids G/sub m,n/ - (u) and G/sub m,n/ - (u,v) are Hamiltonian. 12 figures. (RWR)

25113 (UCID—18620) **Improved monotone piecewise cubic interpolation algorithm.** Fritsch, F.N. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Apr 1980. Contract W-7405-ENG-48. 34p. NTIS, PC A03/MF A01.

A modification of Butland's formula for derivative values that define a monotone piecewise cubic interpolant to monotone data is presented. The new algorithm preserves the simplicity of Butland's method while producing visually pleasing curves comparable to the original Fritsch-Carlson algorithm. 19 figures.

25114 **Odd-even reduction for banded linear equations.** Rodrique, G.H.; Madsen, N.K.; Karush, J.I. (Univ. of California, Livermore). Contract W-7405-ENG-48. *J. Assoc. Comput. Mach.;* **26**: No. 1, 72-81(Jan 1979).

The method of odd-even reduction for tridiagonal systems is generalized to banded systems. The method is developed so that it can be easily implemented on a vector processor such as the CDC STAR-100. Results are presented which describe when this odd-even reduction can be performed on a pentadiagonal system. A computational example is given. 1 table.

25115 **A-posteriori error estimates for the finite element method.** Babuska, I.; Rheinboldt, W.C. (Univ. of Maryland, College Park). Contract E(40-1)3443. *Int. J. Numer. Methods Eng.;* **12**: 1597-1615(1978).

Computable a posteriori error estimates for finite element solutions are derived in an asymptotic form for $h \rightarrow 0$, where h measures the size of the elements. The approach has similarity to the residual method, but differs from it in the use of norms of negative Sobolev spaces corresponding to the given bilinear (energy) form. For clarity the presentation is restricted to one-dimensional model problems. More specifically, the source, eigenvalue, and parabolic problems involving a linear, self-adjoint operator of the second order are considered. Generalizations to more general one-dimensional problems are straightforward, and the results also extend to higher space dimensions; but this extension involves some additional considerations. The estimates can be used for a practical a posteriori assessment of the accuracy of a computed finite element solution, and they provide a basis for the design of adaptive finite element solvers. 2 tables.

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 24175, 24587

25116 (ORNL/TM—7294) **National resource for computation in chemistry, phase I: evaluation and recommendations.** (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 36p. NTIS, PC A03/MF A01.

The National Resource for Computation in Chemistry (NRCC) was inaugurated at the Lawrence Berkeley Laboratory (LBL) in October 1977, with joint funding by the Department of Energy (DOE) and the National Science Foundation (NSF). The chief activities of the NRCC include: assembling a staff of eight postdoctoral computational chemists, establishing an office complex at LBL, purchasing a midi-computer and graphics display system, administering grants of computer time, conducting nine workshops in selected areas of computational chemistry, compiling a library of computer programs with adaptations and improvements, initiating a software distribution system, providing user assistance and consultation on request. This report presents assessments and recommendations of an Ad Hoc Review Committee appointed by the DOE and NSF in January 1980. The recommendations are that NRCC should: (1) not fund grants for computing time or research but leave that to the relevant agencies, (2) continue the Workshop Program in a mode similar to Phase I, (3) abandon in-house program development and establish instead a competitive external postdoctoral program in chemistry software development administered by the Policy Board and Director, and (4) not attempt a software distribution system (leaving that function to the QCPE). Furthermore, (5) DOE should continue to make its computational facilities available to outside users (at normal cost rates) and should find some way to allow the chemical community to gain occasional access to a CRAY-level computer.

CIVILIAN DEFENSE

25117 (PB—300976) **Natural Hazards Observer, volume 2, number 4, June 1978.** White, A.; Waterstone, P. (Colorado Univ., Boulder (USA). Natural Hazards Research and Applications Information Center). Jun 1978. 14p. NTIS, PC A02/MF A01.

The National Hazards Observer is intended to strengthen communication between research workers and the individuals, organizations and agencies concerned with public action relating to natural hazards. The feature article concerns the strengthened commitment of the Federal Disaster Assistance Administration (FDAA) in hazard mitigation. Also included in this issue are discussions of: (1) preparation of 60-second public service announcements for radio and TV by the Civil Defense Preparedness Agency to call attention to the role of local civil defense organizations in peacetime as well as in nuclear disasters; (2) the request by the public for more scientific earthquake prediction and preparedness; (3) a computer-based simulation exercise (ATLANTIS); (4) cooperation between UNESCO and UNDRO (UN Disaster Relief Organization) in earthquake risk research, training, and public education; (5) the endorsement of a resolution by the UN General Assembly which calls for the promotion of measures to facilitate and expedite international relief assistance and to emphasize prevention; (6) a statement of concern that flash floods now rank as the major killer and destroyer among weather-related disasters in the U.S.; (7) estimating the long term effects of floods, tornados, and hurricanes; (8) governors' project on emergency preparedness; (9) emergency evacuation route maps, seismic design and public policy; and (10) geologic awareness. Also included are announcements of conferences, recent publications, Washington Update, and included are annluncements of conference, recent publications, Washington Update, and newly awarded NSF grants.

CORPORATE INDEX

In the Corporate Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

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A

Abacus Controls, Inc., Somerville, NJ (USA)
Design and performance of an 11 kW Solar Array Simulator, 5:23852 (SAND—80-0873C)

Acton Research Corp., MA (USA)
Krypton fluoride laser mirror study. Final report, October 1978-November 1979, 5:24521 (DOE/DP/40001—1)

Acurex Corp., Mountain View, CA (USA). Aerotherm Div.
Environmental assessment of stationary source NOx control technologies. Annual report no. 2, June 1977-June 1978, 5:24547 (PB—300469)

Aerospace Corp., El Segundo, CA (USA). Eastern Technical Div.
Study of hydrogen-powered versus battery-powered automobiles, 5:24340 (ATR—79(7759)-1(Vol.3))
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ALARA, Inc., Lyons, CO (USA)
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Alaska Dept. of Commerce and Economic Development, Juneau (USA)
Jobs and power for Alaskans - a program for power and economic development, 5:24178 (PB—299729)

Alaska Univ., Anchorage (USA). Inst. of Social and Economic Research
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AFR/design and licensing information/BNFP as a model. Technical progress report, January-March 1980, 5:23705 (AGNS—47921-TPR-3)

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Monitoring the performance of solar heated and cooled buildings. Volume 2. Measuring instruments - selection, calibration and installation. Final report, 5:23882 (EPRI-ER—1239(Vol.4))

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Coal liquefaction catalyst development. Quarterly progress report No. 3, October 1-December 31, 1979, 5:23438 (DOE/ET/14803—T4)

AN SSSR, Novosibirsk. Inst. Yadernoj Fiziki
Experiments on high-current proton beams at Novosibirsk, 5:24549 (UCRL-Trans—1592)

Argonne National Lab., IL (USA)
Accurate numerical solutions for elastic-plastic models, 5:24052 (ANL—80-31)
Advanced fuel cell development. Progress report, April-June 1979, 5:24232 (ANL—79-84)
Advanced fuel cell development. Progress report, July-September 1979, 5:24233 (ANL—79-110)
Analysis of an internally pressurized prismatic cell can, 5:24156 (ANL—80-30)
Climate and energy: a comparative assessment of the Satellite Power System (SPS) and alternative energy technologies, 5:23798 (DOE/ER—0050)
Comparative analysis of net energy balance for satellite power systems (SPS) and other energy systems, 5:23850 (DOE/ER—0056)
Comparative assessment of environmental welfare issues associated with the satellite power system (SPS) and alternative technologies, 5:23849 (DOE/ER—0055)
Development of a methodology for analysis of delayed-neutron signals, 5:24051 (ANL—79-57)
Development of advanced batteries at Argonne National Laboratory. Summary report for 1979, 5:24103 (ANL—80-32)
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Emissions and effluent control costs of the US pulp and paper industry, 5:24588 (ANL/EES-TM—83)
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Characteristics of synchrotron radiation and of its sources, 5:24557 (BNL—27678)
Consequences of natural upwelling in oligotrophic marine ecosystems, 5:23862 (BNL—27710)
Economic assessment of alternative energy policies, 5:24201 (BNL—27721)
Electric utilities and residential solar systems, 5:23877 (BNL—27711)
Environmental, Health, and Safety Considerations, 5:23803 (BNL—27720)
Flavor mixing and charm decay, 5:24861 (BNL—27615)
Framework for energy policy and technology assessment in developing countries: a case study of Peru, 5:24200 (BNL—27613)
Fuel cells for electric utility and transportation applications, 5:24234 (BNL—27452)
Generation of approximating distributions through the method of stages, 5:25104 (BNL—27513)
Hybrid photovoltaic/thermal systems with a solar-assisted heat pump, 5:23876 (BNL—27667)
International safeguards at the feed and withdrawal area of a gas centrifuge uranium enrichment plant, 5:23758 (BNL—27663)
Optimization of a synchrotron radiation source, 5:24556 (BNL—27654)
Overview of image reconstruction, 5:25105 (BNL—27665)
R and D activities in pulse combustion at BNL, 5:24248 (BNL—27602)
Relating surveillance capsule measurements to pressure vessel damage, 5:24073 (BNL-NUREG—27192)
Shelf-sea ecosystems, 5:24650 (BNL—27406)
Solar assisted heat pump program overview and summary of work at Brookhaven National Laboratory, 5:23875 (BNL—27662)
Study of coal oxidation by charged particle activation analysis, 5:23452 (BNL—27607)
Use of a synchrotron radiation x-ray microprobe for elemental analysis at the National Synchrotron Light Source, 5:24487 (BNL—27611)
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Between-hole acoustic surveying and monitoring of a granitic rock mass, 5:23731 (LBL—10483)
Catalytic biomass liquefaction, 5:23836 (LBL—10667)
Computerized international geothermal information systems, 5:23979 (LBL—10615)
Conventions and formulas for using the Mueller-Stokes calculus in ellipsometry, 5:24971 (LBL—10172)
Decays of the heavy lepton, tau (1785), 5:24846 (LBL—10801)
Development of solar driven absorption air conditioners and heat pumps, 5:23888 (LBL—10771)
Evaluation of city well 1, Klamath Falls, Oregon, 5:23999 (LBL—10848)
Human comfort and auxiliary control considerations in passive solar structures, 5:23886 (LBL—10034)
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Secondary minerals found in the cores DC2 A1 and DC2 A2 taken from the Grande Ronde Basalt Formation, Pasco Basin, Washington, 5:23730 (LBL—10387)
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Advanced three-dimensional thermal modeling of a baseline spent fuel repository, 5:23710 (UCID—18660)
Application of FRAMIS to K/sub D/ data, 5:23747 (UCID—18651)
BIODOSE: a code for predicting the dose to man from radionuclides released from underground nuclear waste repositories, 5:24654 (UCID—18652)
Buildup studies for MFTF-B, 5:24981 (UCID—18334)
Changing patterns in world nitrogen fertilizer production and trade, 5:24209 (UCID—18621)
Characterization techniques for high quality ICF targets, 5:23760 (UCRL—82530)
Computational methods for reversed-field equilibrium, 5:25018 (UCRL—84044(Rev.1))
Computer modeling of antennas near the ground, 5:24538 (UCID—18626)
Dynamics and modeling of heavier-than-air, cold gas releases, 5:23612 (UCRL—15224)
Estimation of neutral-beam-induced field reversal in MFTF by an approximate scaling law, 5:25051 (UCID—18615)
Examination of the effects of 50 ppB copper on the black abalone, Haliotis cracherodii, 5:24770 (UCRL—52932)
Formal analysis including value judgments and public risk, 5:24186 (UCRL—15226)
Heating by the Raman instability, 5:24983 (UCRL—84270)
Imaging system for obtaining space- and time-resolved plasma images on TMX, 5:24995 (UCRL—83805)
Improved monotone piecewise cubic interpolation algorithm, 5:25113 (UCID—18620)
Initial results of the Tandem Mirror Experiment (TMX) at the Lawrence Livermore Laboratory, 5:25006 (UCRL—84221)
LLL calibration and standards facility, 5:24573 (UCRL—84295)
LLL continental drilling for scientific purposes data base: DOE-funded drill holes, 5:24782 (UCRL—52909)
Modeling propellant combustion interacting with an eroding solid surface, 5:24584 (UCRL—83727)
Need for a contamination control textbook, 5:24517 (UCRL—84327)
Neutron yield measurements on a TMX endplug, 5:25005 (UCRL—52923)
Noise characterization of the linear CCD, 5:24572 (UCID—18622)
Numerical simulation of self-induced rainout using a dynamic convective cloud model, 5:24635 (UCRL—83583)
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Polarizer reflectivity variations, 5:25076 (UCID—18588)
Prediction of heavy element fission barrier features for multiple chance neutron cross-section calculations, 5:24927 (UCRL—84370)
Remarks on the assessment, representation, aggregation and utilization of expert opinion, 5:23749 (UCID—18665)
Review of geochemical measurement techniques for a nuclear waste repository in bedded salt, 5:23748 (UCID—18664)
Rf heating of mirrors, 5:24982 (UCID—18623)
Some implications for mirror research of the coupling between fusion economics and fusion physics, 5:25045 (UCRL—84245)
Space-time energy concentration and the design of DT fusion micro-explosions, 5:25077 (UCRL—81919)
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Tandem mirror fusion fission hybrid studies, 5:25064 (UCRL—84018)
Tritium management in fusion synfuel designs, 5:23765 (UCRL—83928)
Unique rod lens/video system designed to observe flow conditions in emergency core coolant loops of pressurized water reactors, 5:24048 (UCRL—52902)
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Final environmental impact statement: US Spent Fuel Policy. Executive summary, 5:23723 (DOE/EIS—0015(Vol.1))
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Fuel damage estimates for the TMI-2 reactor, 5:24094 (LA-UR—80-1069)
Geophysical logging case history of the Raft River geothermal system, Idaho, 5:23987 (LA—8252-MS)
Geothermal investigation of spring and well waters of the Los Alamos Region, New Mexico, 5:23986 (LA—8326-MS)
Growth rates of interchange modes in the dense z-pinch and gas blanket effects, 5:25024 (LA—8340-MS)
In-progress geologic map of Canon de San Diego, Jemez Springs, New Mexico, and lithologic log of Jemez Springs geothermal well, 5:23984 (LA—8276-MAP)
Investigation of a large solid angle pion channel for a medical application utilizing current sheets and solenoid elements, 5:24554 (LA—8356-MS)
Ionization chamber for measurements of high-level tritium gas, 5:24489 (LA-UR—80-1215)
Kinetic behavior of subbituminous coal drying; effects of confining pressure, 5:23541 (LA-UR—80-551)
LASL Nb_3Ge conductor development. Fourteenth quarterly progress report, October 1-December 31, 1979, 5:24969 (LA—8320-PR)
Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States, 5:23697 (LA-UR—80-1013)
Low-energy nuclear fusion data and their relation to magnetic and laser fusion, 5:24890 (LA—8087)
Measurements of electron heat flow along a dc magnetic field in strong temperature gradients, 5:25013 (LA-UR—80-1109)
Medium-energy physics program. Quarterly progress report, May 1-July 31, 1979, 5:24553 (LA—8293-PR)
Model valence-fluctuation systems: variational ground states and magnetic responses, 5:24955 (LA-UR—80-1005)
Modeling the number of bids received on federal offshore hydrocarbon leases by poisson-type models, 5:23601 (LA—8347-MS)
Modified titrimetric determination of plutonium using photometric end-point detection, 5:24486 (LA—8145)
NDA technology for uranium resource evaluation. Progress report, January 1-June 30, 1979, 5:23696 (LA—8321-PR)
Ohmic heating of the reversed-field pinch, 5:24979 (LA—8325-MS)
Performance and improvements of the tritium handling facility at the Los Alamos Scientific Laboratory, 5:23721 (LA-UR—80-1265)
Plutonium recovery at the Los Alamos Scientific Laboratory, 5:23720 (LA-UR—80-1168)
Post irradiation dose determination of 800 MeV proton irradiated aluminum from LAMPF experiment 407, 5:24422 (LA—8351-MS)
Preliminary analysis of the safety and environmental impact of the Tritium Systems Test Assembly, 5:25068 (LA-UR—80-1249)
Production of field-reversed configurations with a magnetized coaxial plasma gun, 5:25049 (LA-UR—80-1104)

Relativistic electron beam plasma heating experiment, 5:24978 (LA—8226-MS)
Residential solar home resale analysis, 5:23885 (LA-UR—80-1014)
Silver isotopic anomalies in iron meteorites: cosmic-ray production and other possible sources, 5:24801 (LA-UR—80-1199)
Solar wind flows associated with hot heavy ions, 5:24796 (LA—8344-T)
Studies of long-term ecological effects of exposure to uranium V, 5:24647 (LA—8221)
Thermal conductivities of mixed carbide fuel and blanket materials, 5:24058 (LA-UR—80-1283)
Thermodynamics of the tantalum-carbon-chlorine-hydrogen system applied to the CVD of carbide/carbon composite materials, 5:24395 (LA-UR—80-1252)
TMI-2 decay power: LASL fission-product and actinide decay power calculations for the President's commission on the accident at Three Mile Island, 5:24047 (LA—8041-MS(Rev))
Tritium Systems Test Assembly: objectives and design, 5:25066 (LA-UR—79-2971)

M

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DOE/PETC 5MW two-stage MHD pressurized coal combustor. Quarterly activity report, January 1-March 31, 1980, 5:24217 (COO—4049-16)
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High-energy ion expansion in laser-plasma interactions, 5:25023
Laser scattering measurements of plasma turbulence in a fast theta pinch, 5:25009
Measurement of effective ionization and recombination rate coefficients for intermediate iron ions in a laser generated theta-pinch heated plasma, 5:25008
Maryland Univ., College Park (USA). Dept. of Chemistry
Radioactive decay studies at TRISTAN II. Progress report, July 1, 1979-March 31, 1980, 5:24887 (DOE/ER/10494—1)
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Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Nuclear Science
Search for the production of a new quark flavor at the highest PETRA energies, 5:24835 (DOE/ER/03069—770)
Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.
Solar photovoltaic module degradation from electro-migration, 5:23805 (COO—4094-64)
Massachusetts Univ., Amherst (USA)
High statistics measurement of the vector and axial vector coupling constraints in lambda beta decay, 5:24849
Mathematical Sciences Northwest, Inc., Bellevue, WA (USA)
Plasma rotation in reversed-field theta pinches, 5:25025 (MSNW—80-1144-1)
Mathtech, Inc., Princeton, NJ (USA)
Evaluation of the environmental effects of western surface coal mining. Volume II. Mine inventory. Final report, 5:23529 (PB—301249)
Metropolitan Transportation Authority, New York (USA)
Energy storage propulsion system for rapid transit cars. Test results and system evaluation. Final report, 5:24347 (PB—300918)
Miami Univ., Coral Gables, FL (USA)
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New optimal polynomial theory for NN-scattering, 5:24844 (DOE/ER/10516—T2)
Optimized polynomial expansions: potentials and phase shift analyses, 5:24871 (DOE/ER/10516—T3)
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Coping with energy limitations in transportation: proposals for Michigan, 5:24179 (PB—299737)
Minnesota Energy Agency, St. Paul (USA)
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District heating and cooling through power plant retrofit and distribution network. Final report. Phase 1, executive summary, 5:24324 (COO—4980-1(Exec.Summ.))
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A review of standards of performance for new stationary sources - petroleum refineries, 5:24638 (PB—300480)
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Outer continental shelf environmental monitoring concerns. Final report, 5:23607 (PB—299861)
Potential industrial applications for fluidized-bed waste heat recovery systems, 5:24308 (DOE/CS/40255—1)
Mobil Research and Development Corp., Paulsboro, NJ (USA). Process Research and Technical Service Div.
Upgrading of coal liquids for use as power generation fuels. Final report, February 1978-June 1979, 5:23439 (EPRI-AF—1255)
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Montana Energy and MHD Research and Development Inst., Inc., Butte (USA)
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Motorola, Inc., Phoenix, AZ (USA). Semiconductor Group
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Mound Facility, Miamisburg, OH (USA)
Evaluation of solar pond performance, 5:23953 (MLM—2702(OP))
Nickel-iron alloy corrosion in a sealed pyrotechnic system, 5:24413 (MLM—2707(OP))
Power independent ignition energy measurements, 5:24581 (MLM—2709(OP))
Role of surface chemistry in the ignition of pyrotechnic materials, 5:24580 (MLM—2708(OP))
Thermal and electrostatic initiation of TiH/sub x/ based pyrotechnics, 5:24582 (MLM—2710(OP))
X-ray induced auger electron spectroscopic studies on aluminum metal surface films in aluminum/iron oxide thermites, 5:24437 (MLM—2711(OP))

N

NAHB Research Foundation, Inc., Rockville, MD (USA)
Research program on the economic feasibility and commercialization potential of the ACES system. Twenty-fourth periodic progress report, 5:24252 (DOE/CS/02130—T1)
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Effect of catalyst length and downstream reaction distance on catalytic combustor performance, 5:24337 (DOE/NASA/1040—80/14)
Optimization of air separation plants for combined cycle MHD-power plant applications, 5:24222 (DOE/NASA/2674—80/10)
Summary and evaluation of the parametric study of potential early commercial MHD power plants (PSPEC), 5:24218 (DOE/NASA/2674—80/9)

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An investigation of preferences for various types of energy cost feedback. Final report, 5:24212 (PB—300314)
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Aerosols and climate, 5:24589 (CONF-800309—5)
Modeling the prospects for climatic change: current state-of-the-art and implications, 5:24663 (CONF-800474—1)
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Refractory particles in cullet recovered from municipal refuse. Technical report, 5:24328 (PB—300523)
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Ensuring safe operation of the BOR-60 experimental fast reactor as an atomic power plant, 5:24079 (PNL-TR—397)
Study of the operational characteristics of the core and irradiated fuel parameters in the BOR-60 reactor, 5:24060 (PNL-TR—398)
Naval Research Lab., Washington, DC (USA)
Absolute calibration of a prompt gamma ray detector for intense bursts of protons, 5:24563 (NRL-MR—4171)
Hard x-ray spectrum from a one-fluid laser plasma model, 5:25014 (NRL-MR—4241)
Properties of ablatively accelerated targets, 5:25074 (NRL-MR—4212)
XUV spectra of Mo XIII-XVIII, 5:25002 (NRL-MR—4177)
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New York State Museum and Science Service, Albany (USA)
Isopach map of black shale in the Sonyea Group (from well sample studies), 5:23618 (METC/EGSP—108)
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Feasibility of a large district heating-cogeneration system for the Minneapolis-St. Paul area, 5:24189 (CONF-7910156—2)
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Continuous air pollution source monitoring systems, 5:24616 (PB—300930)
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O

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Educational and demographic characteristics of energy-related scientists and engineers, 1976, 5:24332 (DOE/IR/0033—T2)
Energy-related scientists and engineers: a statistical profile of recent entrants into the work force, 1978, 5:24333 (DOE/OR/00033—T1)
UNISOR facility: recent developments and future directions, 5:24552 (CONF-790976—10)
Oak Ridge Associated Universities, Inc., TN (USA). Inst. for Energy Analysis
Options for the collection and disposal of carbon dioxide, 5:24036 (ORNL—5657)

Oak Ridge Gaseous Diffusion Plant, TN (USA)
Cylinder overpack phenolic foam shock testing, 5:24518 (K/P—6567)
Hydrogeochemical and stream sediment detailed geochemical survey for Laramie Range, Wyoming, 5:23690 (GJBX—100(80))
Hydrogeochemical and stream sediment reconnaissance basic data for Dickinson NTMS Quadrangle, North Dakota, 5:23689 (GJBX—99(80))
Hydrogeochemical and stream sediment reconnaissance basic data for Marquette NTMS Quadrangle, Michigan, 5:23693 (GJBX—106(80))
Numerical methods for the analysis of laser annealing of doped semiconductor wafers, 5:24368 (K/CSD/INF—79/27)
Oak Ridge National Lab., TN (USA)
ACFAC: a cash flow analysis code for estimating product price from an industrial operation, 5:24069 (ORNL/TM—7150)
Alpha liquid scintillation counting: past, present, and future, 5:24560 (CONF-790859—3)
Analysis of the initial shielding design for the upflow gas-cooled fast reactor (GCFR), 5:24059 (ORNL/TM—7246)
Annual Cycle Energy System characteristics and performance, 5:24250 (CONF-800524—2)
Attrition and elutriation phenomena in industrial atmospheric fluidized bed combustors, 5:23559 (CONF-800545—1)
Best approach to impact assessment is to use empirically based or simulation models to forecast impacts. Environmental Sciences Division Publication No. 1538, 5:24024 (CONF-800543—2)
Buildings energy use data book. Edition 2, 5:24244 (ORNL—5552)
Calculation of dose-rate conversion factors for external exposure to photons and electrons, 5:24953 (CONF-7810133—6)
Calorimeter for pulsed energy sources, 5:25086 (CONF-791102—165)
Ceramic BeO exoelectron dosimeters for tritium and radon monitoring, 5:24561 (CONF-7910149—1)
Coal, 5:23533 (CONF-790949—3)
Covariances of fission-integral measurements at the NBS ^{252}Cf and ISNF facilities and at the ORNL-PCA facility, 5:24070 (CONF-791051—23)
Dependence of silicon carbide coating properties on deposition parameters: preliminary report, 5:24050 (ORNL/TM—7209)
Determination of K-factors for arbitrarily shaped flaws at pressure vessel nozzle corners, 5:24045 (CONF-791118—11)
Development of impedance sensors at ORNL: for measurement of two-phase flows, 5:24085 (CONF-791118—10)
Development of the ion source for PDX neutral beam injection, 5:25063 (CONF-791102—161)
Direct cryosorption pumping of an energetic hydrogen ion beam, 5:25087 (CONF-791102—171)
Eddy current heating of irregularly shaped plates by slow ramped fields, 5:25048 (CONF-791102—167)
Effective diffusion coefficients of point defects in impure materials, 5:24375 (ORNL/TM—7247)
Electrolysis of molten $NaNO_3$-$AgNO_3$ as test of a model of transport in batteries, 5:24122 (CONF-781063—7)
ENSDF: its structure, contents, and use in applied research, 5:24886 (CONF-791243—1)
Evaluation of a high power submillimeter pulsed laser system, 5:24993 (CONF-800138—1)
Evaluation of the impact of a committed site on fusion reactor development, 5:25044 (CONF-791102—163)
Excitation of giant resonances via charge exchange reactions, 5:24901 (CONF-7910148—1)
Experimental observations of effects of inert gas on cavity formation during irradiation, 5:24423 (ORNL/TM—7193)
Feasibility of a large district heating-cogeneration system for the Minneapolis-St. Paul area, 5:24189 (CONF-7910156—2)
Fission product decay heat for thermal reactors, 5:24084 (CONF-791058—71)
Formaldehyde monitoring program: development of sampling and analysis procedures. Report to the Consumer Product Sampling Commission, 5:24592 (DOE/TIC—11203)
Global perspective on energy, 5:24193 (CONF-800403—43)
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)
Heat-transfer in a partially-blocked sodium-cooled rod bundle, 5:24053 (CONF-791205—23)
High-level waste program progress report, January 1, 1980-March 31, 1980, 5:23722 (ORNL/TM—7371)
HLYWD: a program for post-processing data files to generate selected plots or time-lapse graphics, 5:25015 (ORNL/CSD/TM—109)
HVEM in situ hydriding of hydrogen storage materials, 5:24394 (CONF-791132—5)
Hydrogen recycle modeling in transport codes, 5:25010 (CONF-791057—4)
Identification of technical problems encountered in the shallow land burial of low-level radioactive wastes, 5:23733 (ORNL/SUB—80/13619/1)
Impact of impingement on the Hudson River white perch population, 5:24026 (CONF-800543—4)
Impacts of deep geothermal fluid production on shallow groundwater systems, 5:23983 (CONF-7910155—1)
Implementation of the engineering safeguards program (ESP) into nuclear fuel recycle facilities, 5:23759 (CONF-790707—36)
Infrared reflectiity and transmissivity of boron implanted, laser annealed silicon, 5:24393 (CONF-791112—65)
Initial testing of coated limiters in ISX-B, 5:25088 (CONF-800455—8)
Integral experiments for fusion reactor design: analysis, 5:25084 (CONF-791058—74)
Iodine-129 dose to the world population from the nuclear power industry, 5:24628 (CONF-791103—107)
1000-kVA arc power supply, 5:25052 (CONF-791102—166)
Land use siting considerations for hydrothermal energy facilities, 5:23989 (CONF-800517—4)
Limits to life at low temperatures and at reduced water contents and water activities, 5:24702 (CONF-7810136—2)
Measurement of the 2.35 MeV window in O + n, 5:24992 (CONF-791058—72)
Methods for separating actinides from reprocessing and refabrication plant wastes, 5:23715 (CONF-791112—63)
Modeling decay heat-induced melting of a concrete slab by use of the general heat conduction code HEATING 5, 5:24095 (ORNL/TM—7211)
Monitoring on rights-of-way and the National Biomonitoring Inventory, 5:24642 (CONF-7910141—1)
Mutagenicity testing of aqueous materials from alternate fuel production, 5:24765 (CONF-790663—3)
National energy problem in perspective, 5:24194 (CONF-7910153—1)
National resource for computation in chemistry, phase I: evaluation and recommendations, 5:25116 (ORNL/TM—7294)
Neutron and fuel cycle kinetics analogy, 5:24187 (CONF-791103—110)
New advanced in alpha spectrometry by liquid scintillation methods, 5:24559 (CONF-791117—26)
Note on the robustness of Dixon's ratio test in small samples, 5:25111 (ORNL/TM—7265)
Options for the collection and disposal of carbon dioxide, 5:24036 (ORNL—5657)
ORNL experiments to characterize fuel release from the reactor primary containment in severe LMFBR accidents, 5:24086 (CONF-800434—2)
Overview of nuclear fuel cycle, 5:23671 (CONF-791185—3)
Paramagnetic properties of mixed-matrix NbTi conductors, 5:24513 (CONF-791102—169)
Plenary lecture - a special radioelement problem: ORNL assistance to Three Mile Island in handling contaminated air and water, 5:24083 (CONF-791049—26)
Population-level assessments should be emphasized over community/ecosystem-level assessments. Environmental Sciences Division Publication No. 1535, 5:24025 (CONF-800543—3)
Price incentives of industrial cogeneration, 5:24305 (CONF-800548—1)
Progress on large superconducting toroidal field coils, 5:25047 (CONF-791102—164)
Proposed training program for construction personnel involved in remedial action work at sites contaminated by naturally occurring radionuclides, 5:23756 (CONF-791203—9)
Radioactive Materials Analytical Laboratory, 5:24488 (CONF-791103—111)
Regional ecological assessment approach to atmospheric deposition: effects on soil systems, 5:24643 (CONF-791090—7)
Reproductive survival and macromolecular synthesis in cultured mammalian cells exposed to single metabolites and mixtures of metabolites of benzo(a)pyrene, 5:24762 (CONF-791059—6)

Ring power balance scaling: implications for a reactor, 5:25016 (ORNL/TM—7302)
Room temperature phosphorimetry for the analysis of environmental systems, 5:24651 (CONF-791059—8)
Screening for mutagenic response of six coded chemicals in the CHO/HGPRT system, 5:24763 (CONF-7910146—1)
Shielding of fusion reactors, 5:25085 (CONF-791058—75)
Solving the nuclear reactor core problems, 5:24071 (CONF-791186—1)
Spatial data on energy, environmental, health, and socio-economic themes at Oak Ridge National Laboratory: 1979 inventory, 5:24175 (ORNL—5636)
Stresses in liquid lithium modules in a tokamak blanket due to a changing poloidal magnetic field, 5:25062 (CONF-791102—168)
Structural defects in laser- and electron-beam annealed silicon, 5:24374 (CONF-791112—62)
Swelling and phase instability in neutron irradiated compositional variants of alloy D9, 5:24420 (DOE/TIC—11202)
Testing of low Z coated limiters in tokamak fusion devices, 5:25092 (SAND—79-2105C)
Thermal Energy Storage Test Facility, 5:24249 (CONF-791242—2)
Thermally driven open-cycle heat pump system, 5:24306 (CONF-800549—1)
User's manual for DWNWND: an interactive Gaussian plume atmospheric transport model with eight dispersion parameter options, 5:24633 (ORNL/TM—6874)

Oak Ridge Y-12 Plant, TN (USA)
Evaluation of a laser-induced fluorescence system for uranium analysis, 5:24491 (Y—2205)

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Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation, 5:24330 (PB—300849)
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Which grids are Hamiltonian?, 5:25112 (SAND—80-0438C)

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Owens-Illinois, Inc., Toledo, OH (USA). Solar Energy Products Group
Draining of the SUNPAK/sup TM/ evacuated tubular collector, 5:23949 (ALO—4150-12)

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Glass-ceramics for lightning arrestor connector seals, 5:24429 (SAND—80-0215)
Initial testing of coated limiters in ISX-B, 5:25088 (CONF-800455—8)
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Probe measurements of impurities in the plasma boundary of PLT, 5:25004 (SAND—79-2338C)
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Cuprous oxide photovoltaic cells. Third quarterly technical progress report, October 9, 1979-January 8, 1980, 5:23806 (DOE/ET/23010—12)
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Airborne gamma-ray spectrometer and magnetometer survey: Nulato quadrangle (Alaska). Final report, 5:23677 (GJBX—73(80)(Vol.1))
Airborne gamma-ray spectrometer and magnetometer survey: Sleetmute quadrangle (Alaska). Final report, 5:23680 (GJBX—79(80)(Vol.2))
Airborne gamma-ray spectrometer and magnetometer survey: Iditarod quadrangle (Alaska). Final report, 5:23681 (GJBX—80-(80)(Vol.1))
Airborne gamma-ray spectrometer and magnetometer survey: Nulato quadrangle (Alaska). Final report, 5:23678 (GJBX—73(80)(Vol.2))
Airborne gamma-ray spectrometer and magnetometer survey: Sleetmute quadrangle (Alaska). Final report, 5:23679 (GJBX—79(80)(Vol.1))
Westinghouse Electric Corp., Concordville, PA (USA). Combustion Turbine Systems Div.
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Advanced coal gasification system for electric power generation. Quarterly progress report, October 1-December 31, 1978, 5:23421 (FE—1514-97)
Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.
Final design analyses of CRBRP fuel rod, 5:24054 (CONF-800607—33)
Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.
Joint US-USSR test of the US MHD electrode system in the U-02 facility, Phase III. Final report, 5:24221 (FE—2248-23)
Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center
Silicon materials task of the low cost solar array project (Phase III). Effect of impurities and processing on silicon solar cells. Phase III summary and seventeenth quarterly report, Volume 1: characterization methods for impurities in silicon and impurity effects data base, 5:23809 (DOE/JPL/954331—80/9)
Silicon materials task of the low cost solar array project (Phase III). Effects of impurities and processing on silicon solar cells. Phase III summary and seventeenth quarterly report, Volume 2: analysis of impurity behavior, 5:23810 (DOE/JPL/954331—80/9(Vol.2))
Westinghouse Research and Development Center, Pittsburgh, PA (USA)
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 1. Task I report: literature review, basis for selecting calcium-based sorbents. Final report, 5:24032 (EPRI-FP—1307(Vol.1))
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 2. Tasks II and III report: experimental work, sorbent selection technique. Final report, November 1, 1976-July 31, 1977, 5:24033 (EPRI-FP—1307(Vol.2))
Design properties of steels for coal conversion vessels. Interim report, 5:23419 (EPRI-AF—1242)
West Virginia Univ., Morgantown (USA). Dept. of Mineral Economics
Quadratic programming and spatial equilibrium: the case of coal. Program working papers, 5:23566 (PB—301365)
Role of energy in the Indonesian economy, 1975 to 2000, 5:24206 (PB—301135)
Wisconsin Univ., Madison (USA)
Vacuum ultraviolet spectroscopic study of plasma impurities in the Tokapole II poloidal, 5:25001
Wisconsin Univ., Madison (USA). Dept. of Metallurgical and Mineral Engineering
Effect of principal stress magnitudes on hydrofracturing orientation, 5:24791 (UCRL—15234)
Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering
Growth of molten core debris pools in concrete. Part II. A. Pool growth in composite beds; B. Effect of overlaying steel layers. Final report, March 1, 1978-September 30, 1979, 5:24090 (COO—4261-14)
Wisconsin Univ., Milwaukee (USA). Coll. of Engineering and Applied Science
Pumped storage development and its environmental effects. Final report Dec 1971-May 1974, 5:23794 (PB—299691)
Wiss, Janney, Elstner and Associates, Inc., Northbrook, IL (USA)
Control of vibration and blast noise from surface coal mining. Volume I. Open file report (final) 1 July 1975-28 February 1978, 5:23519 (PB—299887)

Control of vibration and blast noise from surface coal mining. Volume IV. Executive report. Open file report (final) 1 July 1975-28 February 1978, 5:23522 (PB—299890)
Control of vibration and blast noise from surface coal mining. Volume II. Open file report (final) 1 July 1975-28 February 1978, 5:23520 (PB—299888)
Control of vibration and blast noise from surface coal mining. Volume III. Open file report (final) 1 July 1975-28 February 1978, 5:23521 (PB—299889)

Wyoming Univ., Laramie (USA). Water Resources Research Inst.
Water development in Wyoming: a study of resident attitudes, 1971. Completion report, 5:24657 (PB—300495)

X

Xerox Palo Alto Research Center, CA (USA)
Defect states in plasma-deposited a-Si:H. Final report, February 1979-January 1980, 5:24457 (DOE/ET/23033—16)

Y

Yale Univ., New Haven, CT (USA). Dept. of Physics
Dynamical criteria for a unified gauge theory (including gravity), 5:24876 (COO—3075-224)

AUTHOR INDEX

Authors "surnames are indexed in the form appearing in the abstracted publication; given names are reduced to initials. Each author entry gives the publication title and the citation number. Report numbers, if applicable, are given in parentheses at the end of the entry. For publications with multiple authors, an author entry is provided for each. Entries for the second and succeeding authors give references to the first author.

Because of problems involved in the mechanical preparation of this index, all accent marks are omitted. Changes in spelling introduced as a result of accent omission follow standard conventions.

A

Abashian, A., *See* Heisterberg, R.H., 5:24848

Abbatiello, L.A., Annual Cycle Energy System characteristics and performance, 5:24250 (CONF-800524—2)

Abbott, J.M., *See* Staiger, P.J., 5:24218

Abbott, L.F., QCD phenomenology of deep-inelastic scattering, 5:24862

Abdel-Khalik, S.I., Growth of molten core debris pools in concrete. Part II. A. Pool growth in composite beds; B. Effect of overlaying steel layers. Final report, March 1, 1978-September 30, 1979, 5:24090 (COO—4261-14)

Natural convection in inclined two-dimensional compound parabolic concentrators, 5:23972

Abell, G.C., *See* Tadlock, W.E., 5:23753

Abraham, K.M., Safety aspects of Li/$SOCl_2$ batteries, 5:24153

Abrahamsson, B.J., Conservation and the changing direction of economic growth, 5:24199

Abrams, G.S., *See* Himel, T.M., 5:24840

Ackerman, F.J., Oil Shale Project Run summary. Small Retort Run S-16, 5:23639 (UCID—18618)

Adair, G.M., Unstable, non-mutational expression of resistance to the thymidine analogue, trifluorothymidine in CHO cells, 5:24764

Adair, R.K., *See* Morse, W.M., 5:24847

Adam, M.F., Method and means of packaging nuclear fuel rods for handling, 5:24076

Adams, A.A., *See* Walker, G.W., 5:24239

Adams, G.S., 800-MeV inelastic proton scattering from ^{40}Ca, ^{48}Ca, and ^{54}Fe, 5:24911

Adams, J.W., *See* Peters, E.T., 5:24607

Adams, L.M., *See* Ullrich, R.L., 5:24748

Adams, R., *See* Hine, G.J., 5:24562

Adlhart, O.J., Assessment of the air breathing, hydrogen fueled SPE fuel cell, 5:24237

Adt, R.R. Jr., Hydrogen engine performance analysis project. Second annual report, 5:24357 (SAN—1212-T1)

Afanas'ev, V.A., *See* Gryazed, V.M., 5:24079

Afanasiev, V.A., *See* Gryazev, V.M., 5:24060

Ahlen, S.P., *See* Salamon, M.H., 5:24950

Ahn, Y.K., Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model). Quarterly technical progress report, Februray 1, 1980-April 30, 1980, 5:23835 (DOE/ET/20611—12)

Aigner, D.J., Electricity demand and consumption by time-of-use: a survey. Final report, 5:24197 (EPRI-AF—1294)

Akinc, M., Cement as admixture to fly ash concrete, 5:24311 (METC/SP—79/10(Pt.2), pp 570-578)

Akutagawa, W.M., Increased tissue differentiation using color display of multiple-energy CT scans, 5:24721

Alam, M.S., *See* Himel, T.M., 5:24840

Albersheim, P., *See* Wade, M., 5:24728

Alberts, J.J., Distribution of $^{239,240}Pu$, ^{238}Pu, and ^{137}Cs in various particle size classes of Lake Michigan sediments, 5:24655

Aldina, G.J., *See* Jahnke, J.A., 5:24616

Aleti, A., *See* Nebgen, J.W., 5:23506

Alexander, C.K. Jr., *See* Rost, D.F., 5:23936

Alexander, W.K., *See* Frantz, C.E., 5:24066

Alexandrou, C., *See* Hodby, J.W., 5:24468

Alexeff, Igor, Critical survey of ion-acoustic waves, 5:25036

Alford, H.E., *See* Veatch, F., 5:23640

Alford, P., *See* Brown, R.E., 5:24917

Alford, W.P., (^3He, n) reaction on tellurium isotopes, 5:24918

Allan, D.E., Slurry hydrogen treating processes, 5:23595

Allen, B.R., *See* Fink, D.J., 5:23833

Allen, C.C., *See* Baldwin, V.H., 5:24315

See Longua, K.J., 5:24063

Allen, D.J., Solar industrial process steam: an economic analysis, 5:23909 (SERI/TP—333-429, pp 69-74)

Allen, D.W., Final sulfur removal in ammonia from coal plants, 5:23416

Allen, E.J., Nondestructive fissile isotopic measurement technique for Uranium-233 - Uranium-235 fuels using prompt and delayed fission neutron counting, 5:24483

Allen, G.C., Surface oxidation of nickel metal as studied by x-ray photoelectron spectroscopy, 5:24419

Allen, R.J., Energy savings by means of fuel cell electrodes in electro-chemical industries. Progress report, August 1-October 31, 1978, 5:24498 (COO—4881-3)

Allvey, G.W., *See* Jumel, Y., 5:24147

Alsmiller, R.G. Jr., Shielding of fusion reactors, 5:25085 (CONF-791058—75)

See Santoro, R.T., 5:25084

Altenbach, T.J., Advanced three-dimensional thermal modeling of a baseline spent fuel repository, 5:23710 (UCID—18660)

Alvin, M.A., *See* Ulerich, N.H., 5:24033

Alyea, E.D. Jr., *See* Brick, D., 5:24854

Ameduri, G.J., *See* Rost, D.F., 5:23936

Amer, N.M., *See* Jackson, W., 5:24575

An, C.H., Study of MHD instabilities in elongated tokamaks, 5:25033

Anand, J., *See* Tsang, F.Y., 5:24124

Ander, M.E., *See* Jiracek, G.R., 5:24789

Anderson, C.A., Improved structural silicon nitride materials containing rare earth oxides, 5:24433

See Grubb, D.P., 5:25006

Anderson, D., Effect of catalyst length and downstream reaction distance on catalytic combustor performance, 5:24337 (DOE/NASA/1040—80/14)

Anderson, H.L., Evidence for quarks and gluons, 5:24970 (LA—8310-MS)

Anderson, J.H., Transortation Control Plan. Volume 3: Technical Documentation, 5:24599 (PB—297525)

Anderson, J.L., Design and construction of the Tritium Systems Test Assembly, 5:25067 (LA-UR—80-1203)

Tritium Systems Test Assembly: objectives and design, 5:25066 (LA-UR—79-2971)

Anderson, K.A., *See* Potter, D.W., 5:24797

Anderson, N.G., System for loading slab-gel holders for electrophoresis separation, 5:24492

See Giometti, C.S., 5:24673, 5:24676

See Willard, K.E., 5:24674

Anderson, N.L., *See* Anderson, N.G., 5:24492

See Giometti, C.S., 5:24673, 5:24676

See Willard, K.E., 5:24674

Anderson, O., *See* Carey, D., 5:23534

Anderson, R.E., *See* Alford, W.P., 5:24918

Anderson, T.D., Global perspective on energy, 5:24193 (CONF-800403—43)

Anderson, W.W., *See* Jonath, A.D., 5:23807

Andersson, B., *See* Place, W., 5:23886

Andrews, H.R., *See* Haas, B., 5:24923

Andrews, J.W., Solar assisted heat pump program overview and summary of work at Brookhaven National Laboratory, 5:23875 (BNL—27662)

Angello, J.P., Thermoelectric generator overload protective device using hysterisis control, 5:24230

Angevine, P.J., Upgrading of coal liquids for use as power generation fuels.

Final report, February 1978-June 1979, 5:23439 (EPRI-AF—1255)
Angres, I.A., Heat and chemically resistant membranes, 5:24166
Anthony, R.G., Conversion of coal-based methanol to ethylene and a gaseous fuel. Final report 1 October 1975-30 September 1978, 5:23773 (PB—301256)
Antipin, G.K., *See* Gryazed, V.M., 5:24079
Anwer, J., *See* Bailey, E.E., 5:23783
Applegate, J.K., Geophysical logging case history of the Raft River geothermal system, Idaho, 5:23987 (LA—8252-MS)
Aquila, V.S., Solar energy system performance evaluation, Hogate's Restaurant, Washington, DC, June-August, 1978, 5:23941 (SOLAR/2028—78/14)
Arai, T., Functional-derivative study of the Hubbard model. III. Fully renormalized Green's function, 5:24960
Quasiparticle excitations, the relaxation, and transport properties in the narrow-band regionof the Hubbard model, 5:24962
Stability of the split-band solution and energy gap in the narrow-band region of the Hubbard model, 5:24961
Arakawa, E.T., *See* Petrakian, J.P., 5:24398
See Williams, M.W., 5:24412
Ardouin, D., *See* Brown, R.E., 5:24917
Armbruster, P., *See* Liesen, D., 5:24827
Armento, W.J., Implementation of the engineering safeguards program (ESP) into nuclear fuel recycle facilities, 5:23759 (CONF-790707—36)
Armstrong, C.M., *See* Ripin, B.H., 5:25082
Armstrong, P.R., Monitoring the performance of solar heated and cooled buildings. Volume 2. Measuring instruments - selection, calibration and installation. Final report, 5:23882 (EPRI-ER—1239(Vol.4))
Arnold, R.C., Hearthfire reference concept No. 3. A rapid cycling synchrotron system, 5:24551 (ACC—6)
Aronov, V., Study of the interactions between friction, wear and system rigidity. Progress report, July 1, 1979-June 30, 1980, 5:24509 (DOE/ER/10471—1)
Aronson, A.L., *See* Carew, J.F., 5:24073
Arthur, M.D., Oscillations and waves in anisotropic plasmas, 5:25042
Arvidson, A., *See* McCormick, J.R., 5:23815
Asbridge, J.R., *See* Gosling, J.T., 5:24798
Asbury, J., Energy performance standards for new buildings: impact on the use of customer storage, 5:24243 (ANL/EES-TM—81)
Aschman, D., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Ashby, J.B., Australian cenospheres, 5:23469 (METC/SP—79/10(Pt.1), pp 134-139)
Characteristics of Australian flyash concrete, 5:23486 (METC/SP—79/10(Pt.2), pp 508-521)
Ashley, J.C., Electron mean free paths in solid organic insulators, 5:24724
See Williams, M.W., 5:24412
Ashok, S., *See* Kar, S., 5:24539
Asplund, R.O., *See* Lawlor, D.L., 5:23630
See Skinner, Q.D., 5:23664
Atallah, S., Natural gas pipeline safety in residential areas served by master meters. a handbook, 5:23611 (PB—300118)
Athens, P., *See* Atallah, S., 5:23611
Atkinson, G.B., *See* Baglin, E.G., 5:23774
Attewell, A., *See* Doran, R.J., 5:24172
Atwood, M.T., Chemical and physical properties of oil shale dust and correlations with laboratory fire and explosivity test results, 5:23650
Aubeau, R., Effect of the degree of hydration of the adsorbent on the chromatographic analysis of common gases, 5:24493 (DP-TR—9)
Auer, H.E., Actinomycin D-deoxynucleotide interactions: binding isotherms at the benzenoid and quinoid portions of the drug, 5:24692
Auerbach, L.B., *See* Highland, V.L., 5:24843
Auerbach, S.P., *See* Boyd, J.K., 5:25018
Austing, J.L., Design and evaluation of progressively burning pyrotechnic formulations, 5:24583 (SAND—80-0355C)
Auweter, H., *See* Harris, C.B., 5:24476
Avitzur, B., Potential for energy conservaton in the metal forming industries. Progress report, July 1, 1978-August 15, 1979, 5:24297 (COO—4930-1)
Ayala, F.J., *See* Snyder, T.P., 5:24713
Azari, M., *See* Doscher, T., 5:23577

B

Babb, M.C., Applications of computer graphics to integrated environmental assessments of energy systems. Milestone report 1976-77, 5:24185 (PB—300358)
Babcock, A.W., *See* Faber, J.H., 5:23460, 5:23482, 5:23511, 5:23512, 5:24314
Babu, K.H., *See* Chopra, S.K., 5:23492
Babuska, I., A-posteriori error estimates for the finite element method, 5:25115
Badham, V.C., Accidental criticality of a fusion-fission hybrid blanket design, 5:25070
Baer, D.R., *See* Thomas, M.T., 5:24407
Baes, C.F. Jr., Options for the collection and disposal of carbon dioxide, 5:24036 (ORNL—5657)
Baglin, E.G., Catalyst for synthesis of methanol, 5:23774
Bailey, E.E., Winkler coal gasification process and its application in ammonia synthesis plants, 5:23783
Bailey, W.J., *See* Johnson, A.B. Jr., 5:23709
Bailly-Lacresse, J.G., Production of lubricants, 5:23589
Bain, T., *See* Finn, M.G., 5:24332
Bajaj, R., *See* Rowcliffe, A.F., 5:24372
Bak, C.S., *See* Gaven, J.V. Jr., 5:23996
Baker, B.S., *See* Leyerle, R.W., 5:24241
Bakumenko, O.D., Use of demonstration fast reactor experience in assessing the radiation safety of fast power reactors in the design stage, 5:24061 (PNL-TR—393)
Baldwin, D.E., Generating end plug potentials in tandem mirror plasma confinement by heating thermal particles so as to escape low density end stoppering plasmas, 5:24977
Baldwin, G.C., Two-stage pumping of three-level Moessbauer gamma-ray lasers, 5:24525
Baldwin, V.H., Environmental and resource conservation considerations of steel industry solid waste. Final report May 1978-February 1979, 5:24315 (PB—299919)
Ballard, S.C., *See* White, I.L., 5:23668
Bamberger, C.E., Thermochemical cyclic system for splitting water and/or carbon dioxide by means of cerium compounds and reactions useful therein, 5:23769
Bame, S.J., *See* Gosling, J.T., 5:24798
Banas, J.F., Technology assessment: line-focus concentrators, 5:23958 (SERI/TP—333-429, pp 373-383)
Bangham, J.W., *See* Russel, W.L., 5:24774
Bannerot, R., *See* Kreith, F., 5:23975
Barber, D.P., Search for the production of a new quark flavor at the highest PETRA energies, 5:24835 (DOE/ER/03069—770)
Barber, G.C., *See* Kim, J., 5:24987
See Menon, M.M., 5:25063
See Wright, R.E., 5:25052
Barbic, L., *See* Kocuvan, I., 5:24462
Bard, C.S., *See* Butz, T.R., 5:23690
Bard, F.E., TEMP: a computer code to calculate fuel pin temperatures during a transient, 5:24093 (HEDL-TME—75-85)
Bardeen, W.A., *See* Lee, C., 5:24885
Barhorst, J.F., *See* Larson, B.C., 5:24478
Barker, D.H., Improvement and verification of fast reactor safety analysis techniques. Progress report, October 1, 1979-March 31, 1980, 5:24089 (COO—2571-19)
Barker, J.F., *See* Copenhaver, E.D., 5:24175
Barker, L.K., *See* Stagner, M.J., 5:23629
Barnes, J.M., *See* Santoro, R.T., 5:25084
Barney, G.S., *See* Routson, R.C., 5:23740
Barnhart, B.J., Mutagenicity and cytotoxicity of 4.4-MeV α particles emitted by plutonium-238, 5:24739
Barnhouse, L., Crisis intervention programs in Federal Region III: a policy perspective, 5:24180 (PB—300758)
Barnthouse, L.W., Impact of impingement on the Hudson River white perch population, 5:24026 (CONF-800543—4)
Barrella, J., *See* Taylor, H., 5:24141
Barrett, K., A review of standards of performance for new stationary sources - petroleum refineries, 5:24638 (PB—300480)
Barrette, J., *See* Braun-Munzinger, P., 5:24895
See Egelhof, P., 5:24892
See Paul, M., 5:24904
See Tserruya, I., 5:24907
Barriero, F., *See* Brick, D., 5:24854
Barth, E.A., Investigation of the effects of the installation of an oxidation catalyst on a diesel powered vehicle. Technical report, 5:24351 (PB—299928)
Barthelemy, R.R., Alternative power sources for air force terrestrial requirements, 5:24247
Barthell, B.L., *See* Springer, R.W., 5:24380
Bartholdi, M., Differential light scattering photometer for rapid analysis of single particles in flow, 5:24576
Bartholomew, C.H., Alloy catalysts with monolith supports for methanation of coal-derived gases. Quarterly technical progress report, June 21-September 20, 1979, 5:23425 (FE—2729-8)
Bartlit, J.R., *See* Kerr, E.C., 5:25069
Bassham, J.A., *See* Kaiser, W.M., 5:24706
Batay-Csorba, P.A., *See* Alford, W.P., 5:24918
Bates, E., *See* Thoem, T., 5:23669
Bates, J.F., Relationship between swelling and the shear modulus of irradiated metal, 5:24421 (HEDL-SA—1774-FP)
Bauer, D.P., *See* Steele, T.D., 5:24658
Bauer, T.S., *See* Adams, G.S., 5:24911
Bauer, W.V., Hydrotreating of pyrolysis gasoline, 5:23594
Baughman, W.J., Modified titrimetric determination of plutonium using photometric end-point detection, 5:24486 (LA—8145)
Baum, J.W., *See* Varma, M.N., 5:24723
Bauman, H.F., Development of a lithium-water-air battery, 5:24119

Baumann, N.P., Energy dependence of the ^{238}U thermal capture cross section, 5:24936 (DP-MS—79-106)
Bayard, M., *See* Hong, H.Y.P., 5:24435
Bayfield, J.E., Charge exchange measurements in helium using a double tandem accelerator-decelerator source of low energy highly stripped oxygen ions, 5:24826
See Gardner, L.D., 5:24824
Baysinger, F.R., Liquefied natural gas tank construction, 5:23614
Bazshushtari, A., *See* Doscher, T., 5:23577
Beachy, B., *See* Barnhouse, L., 5:24180
Beall, S.E., *See* Baes, C.F. Jr., 5:24036
Bean, R.M., *See* Routson, R.C., 5:24645
Beard, D.S., *See* Haubenreich, P.N., 5:25047
Bechtold, R.A., Deposition and control of ^{7}Be in liquid lithium, 5:25090 (HEDL-SA—1889-FP)
Beck, B., Koppers-Totzek coal gasification process and its role in today's coal-based nitrogenous fertilizer production, 5:23784
Becker, M., *See* Angevine, P.J., 5:23439
Becker, P.D., Lurgi pressure gasification and its application for ammonia manufacture, 5:23782
Becker, U., *See* Barber, D.P., 5:24835
Beckmann, F., *See* Weber, H., 5:23411
Beckwith, C.A., *See* Landry, E.F., 5:24726
Begay, F., Novel photographic method of recording images from cellulose nitrate film, 5:24579
Behrens, R.G., Thermodynamics of the tantalum-carbon-chlorine-hydrogen system applied to the CVD of carbide/carbon composite materials, 5:24395 (LA-UR—80-1252)
Beidleman, C.R., *See* Avitzur, B., 5:24297
Bekofske, K.L., *See* Giles, W.B., 5:24034
Bel'chenko, Yu.I., Experiments on high-current proton beams at Novosibirsk, 5:24549 (UCRL-Trans—1592)
Bell, C., *See* Howard, N.W., 5:24782
Bell, S.E., Energy-related scientists and engineers: a statistical profile of recent entrants into the work force, 1978, 5:24333 (DOE/OR/00033—T1)
Benary, O., *See* Brick, D., 5:24854
Benda, H., *See* Barber, D.P., 5:24835
Bengtson, R.D., Observations of plasma wave states, 5:25043
Bengtsson, S., Method for recovering concentrated sulphur dioxide from waste gases containing sulphur dioxide, 5:23513
Bennett, C.B., Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Bennett, D., Genetic and developmental study of a complex locus in the house mouse. Progress report, August 1, 1978-June 1, 1979, 5:24709 (COO—4159-5)
Bennett, M.E., Alaska OCS socioeconomic studies program. Technical report No. 36. Northern Gulf of Alaska petroleum development scenarios: sociocultural impacts, 5:23603 (PB—300699)
Bennett, R., *See* Markin, T.L., 5:24164
Benson, G.L., *See* Brandstetter, A., 5:23737
Benson, S.M., Evaluation of city well 1, Klamath Falls, Oregon, 5:23999 (LBL—10848)
Beohm, A., *See* Barber, D.P., 5:24835
Berg, C.A., Energy conservation in industry; the present approach, the future opportunities. Final report, 5:24302 (PB—301244)
Berg, D., Radiative width of the rho^{-} meson, 5:24841
Berk, H.L., *See* Boyd, J.K., 5:25018
Berk, J.V., *See* Hollowell, C.D., 5:24624
Berman, B., *See* DeLuca, W.H., 5:24154
Berry, H.G., *See* Gabrielse, G., 5:24810
See Gay, T.J., 5:24811
Berta, V.T., Modeling a nuclear reactor for experimental purposes, 5:24087 (CONF-800536—1)
Berven, B.A., Proposed training program for construction personnel involved in remedial action work at sites contaminated by naturally occurring radionuclides, 5:23756 (CONF-791203—9)
Betts, R.R., *See* Mortensen, M.H., 5:24924, 5:24925
Betz, J.F., *See* Schmidt, F.J., 5:23831
Betz, M., Phenomenological relativistic quantum mechanics of the NNπ system, 5:24945
Bevelacqua, J.J., Comparison of analyzing powers and polarizations for the charge symmetric reactions $^{2}H(d,p)^{3}H$ and $^{2}H(d,n)^{3}He$, 5:24888
Beveridge, J.H., *See* Linhardt, H.D., 5:23412
Bevington, P.R., *See* Winkelmann, E., 5:24891
Bezzerides, B., Randomness, Maxwellian distributions and resonance absorption, 5:24989
Bhanot, G., Phase diagram of Z(N) and U(1) gauge theories in three dimensions, 5:24879
Bhattacharjee, A., Energy principle with global invariants, 5:25017 (PPPL—1659)
Bialas, A., Simple quantum-chromodynamic parametrizations of parton distributions beyond the leading order of asymptotic freedom, 5:24857
Biel, J., *See* Berg, D., 5:24841
Bionta, R.M., Search for narrow p-barp states in the reaction $\pi^{+} p \rightarrow \Delta/sub\ f/^{++}$ p-barp, 5:24852
Bird, W.L., *See* Gully, J.H., 5:25057
Birkelund, J.R., *See* Wilcke, W.W., 5:24937
Birt, D., Characteristics of the aluminium-lithium/iron sulfide cells in immobilised salt electrolytes, 5:24125
Bis, R.F., *See* Warburton, D.L., 5:24130
Bishop, B.A., Final design analyses of CRBRP fuel rod, 5:24054 (CONF-800607—33)
Bishop, F.S., Report on the progress of regulations to protect stratospheric ozone. Annual report 1978-79, 5:24622 (PB—301368)
Bishop, W.S., *See* Brown, R.A., 5:24137
Bissell, M.J., Is the product of the src gene a promoter, 5:24714
See Schwarz, R.I., 5:24708
Black, J.M., Voltage regulator for battery power source, 5:24157
Blackburn, M.J., *See* Law, C.C., 5:24389
Blair, A., Emergency of the auto as the free vote mode, 5:24286
Blais, P.D., *See* Hopkins, R.H., 5:23809, 5:23810
Blakey, B.H., Solar heat roofing system, 5:23963
Blankenbecler, R., Orthogonal transforms and lattice field theories, 5:24878
Blann, M., Decay of deformed and superdeformed nuclei formed in heavy ion reactions, 5:24910
Blatt, S.R., *See* Morse, W.M., 5:24847
Bleiberg, M.L., *See* Rowcliffe, A.F., 5:24372
Blinc, R., *See* Kocuvan, I., 5:24462
Bliss, W.A., *See* Potter, G.D., 5:24630
Block, D.A., Direct gainhome using concrete cored slab, 5:23903
Blocker, C.A., Decays of the heavy lepton, tau (1785), 5:24846 (LBL—10801)
See Himel, T.M., 5:24840
Blomeke, J.O., Overview of nuclear fuel cycle, 5:23671 (CONF-791185—3)
See Tedder, D.W., 5:23715
Bloom, E., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Bloomfield, R.A., *See* Peterson, R.W., 5:23645
Blue, J.L., Buildings energy use data book. Edition 2, 5:24244 (ORNL—5552)
Blumenthal, R., Incorporation of transport molecules into black lipid membranes, 5:24707
Blunt, R.M., *See* Williams, R.E., 5:23651
Boatner, L.A., *See* Hodby, J.W., 5:24468
Bobrowski, G., *See* Morris, J.S., 5:23457
Bobrowski, G.S., Laboratory study of the effects of SO_3 and autoclave expansion of fly ash on concrete expansion and compressive strength, 5:23485 (METC/SP—79/10(Pt.2), pp 496-507)
Bock, T.H., Perspectives of the uranium industry, 5:23713
Bockelman, C.K., *See* Mortensen, M.H., 5:24924, 5:24925
Bodek, A., Sources of prompt leptons in hadronic collisions, 5:24850
Bodner, S.E., *See* Ripin, B.H., 5:25074, 5:25082
Boehm, R., *See* Kreith, F., 5:23975
Boerner, H.G., *See* Cizewski, J.A., 5:24932
Bogert, D., *See* Brick, D., 5:24854
Bogner, F., *See* Bailey, E.E., 5:23783
Bogorad, L., *See* Ohad, I., 5:24677
Bohannon, G., *See* Marker, D., 5:24871
Bokowski, G., *See* Majidzadeh, K., 5:23502
Boley, C.D., Time-dependent pair distribution in the mean-field approximation, 5:24825
Boling, N.L., *See* Rapp, C.F., 5:23829
Bolivar, S.L., Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States, 5:23697 (LA-UR—80-1013)
Boller, J.R., Status of the upgraded version of the NRL GAMBLE II pulse power generator, 5:25054
Bolt, J., *See* Rafferty, C.N., 5:24682
Bomar, E.S., *See* Till, J.E., 5:23704
Bond, P.D., *See* Kubono, S., 5:24908
Bond, W.D., *See* Till, J.E., 5:23704
Bonner, N.A., BIODOSE: a code for predicting the dose to man from radionuclides released from underground nuclear waste repositories, 5:24654 (UCID—18652)
Bonzom, A., *See* Bailly-Lacresse, J.G., 5:23589
Bonzon, L.L., *See* Lurie, N.A., 5:24097
Boone, C.G., *See* Linhardt, H.D., 5:23412
Boone, D.H., Advanced electron beam techniques for metallic and ceramic protective coating systems, 5:24293 (LBL—10520)
Boone, J.W., Coal transportation systems performance, a current assessment, 5:23555
Booth, N.E., *See* Heisterberg, R.H., 5:24848
Booth, T.E., *See* Thompson, W.L., 5:24057
Boozer, A.H., Guiding center drift equations, 5:25019
Bordner, G.L., Nonlinear analysis of laminar boundary layer flow over a periodic wavy surface: Part II: Long waves, 5:24832
Borg, I.Y., *See* Briggs, C.K., 5:24209
Borie, E., X-ray yields in protonium and mesic hydrogen, 5:24818
Bosch, F., *See* Liesen, D., 5:24827
Bosco, G.B. Jr., *See* Linhardt, H.D., 5:23412
Bostick, K.V., *See* White, G.C., 5:24647
Boudreaux, D.S., Hot carrier injection at semiconductor-electrolyte junctions, 5:24542
Boudrie, R.L., *See* Kaellne, J., 5:24889
Bowden, W., *See* Taylor, H., 5:24141
Bowring, J., Selected federal tax and non-tax subsidies for energy use and

production. Energy policy study, Volume 6. AR/EA/80-01, 5:24202 (DOE/EIA—0201/6)
Box, W.D., *See* Armento, W.J., 5:23759
Boyarski, A.M., *See* Himel, T.M., 5:24840
Boyce, B., *See* Wahlig, M., 5:23887
Boyd, J.K., Computational methods for reversed-field equilibrium, 5:25018 (UCRL—84044(Rev.1))
Bracco, F.V., Formation and control of fuel-nitrogen pollutants in catalytic combustion of coal-derived gases. Quarterly technical progress report, December 15, 1978-March 15, 1979, 5:23426 (FE—2762-7)
Bradbury, H.W., Use and potential for fly ash in grouting, 5:23509 (METC/SP—79/10(Pt.2), pp 911-929)
Bradley, D.J., *See* Brandstetter, A., 5:23737
Bradley, J.O., *See* Ochs, T.L., 5:23957
Braendlein, R.K., Ram air turbine power supplies for high performance flight vehicles, 5:24339
Braga, R.A., *See* Gnade, B.E., 5:24815
Brandenburg, J.E., *See* Sahlin, H.L., 5:25077
Brandow, B.H., Model valence-fluctuation systems: variational ground states and magnetic responses, 5:24955 (LA-UR—80-1005)
Brandstetter, A., Waste Isolation Safety Assessment Program. Technical progress report for FY-1978, 5:23737 (PNL—2874)
Branscome, M.R., *See* Baldwin, V.H., 5:24315
Branson, J.G., *See* Barber, D.P., 5:24835
Branton, D., *See* Tyler, J.M., 5:24704
Brar, S.S., *See* Kanabrocki, E.L., 5:24484
Braski, D.N., *See* Lauf, R.J., 5:24050
Brau, J.F., *See* Brick, D., 5:24854
Brault, J.W., *See* Galehouse, D.C., 5:24816
Brauman, S.K., Fire retardant polymers in electrical wire and cable, 5:24449 (EPRI-EL—1263, pp 5.1-5.17)
Braun, G.W., DOE Solar Thermal Power Systems Program, 5:23856 (SERI/TP—333-429, pp 1-32)
Braun-Munzinger, P., Coherence angle in heavy-ion reactions, 5:24895
See Egelhof, P., 5:24892
See Tserruya, I., 5:24907
Braunstein, J., *See* Vallet, C.E., 5:24122
Breidenbach, M., *See* Himel, T.M., 5:24840
Breiter, M.W., Structure of the sulfur electrode in sodium-sulfur cells and comparison with model predictions, 5:24159
Bremner, R.O., Review of the approaches to improving the flame resistance of wire and cable insulating and jacketing materials, 5:24447 (EPRI-EL—1263, pp 10.1-10.9)
Brenchley, D.L., *See* Cone, B.W., 5:24182
Brennan, M., *See* Gully, J.H., 5:25057
Bressan, R.A., *See* Handa, A.K., 5:24672
Breton-Gorius, J., Absence of erythroblastic islands in plasma clot culture nd their possible reconstitution after clot lysis, 5:24729
Brick, D., Leading particles and diffraction dissociation in 150-GeV/c π^- p interactions, 5:24854
Bridger, N.J., *See* Markin, T.L., 5:24164
Bridger, R.F., *See* Yan, T.Y., 5:23597
Bridges, J.E., *See* Snow, R.H., 5:23632
Briggs, C.K., Changing patterns in world nitrogen fertilizer production and trade, 5:24209 (UCID—18621)
Briggs, J., *See* Skelton, R., 5:24535
Bright, R., Electric utilities and residential solar systems, 5:23877 (BNL—27711)
Brimer, P.A., *See* Hsie, A.W., 5:24763
Britov, V.N., *See* Gryazed, V.M., 5:24079
Britt, H.C., *See* Wilhelmy, J.B., 5:24938
Britt, J.F., Heliostat production evaluation and cost analysis, 5:23962 (SERI/TR—8052-1)
Brittingham, J.N., *See* Burke, G.J., 5:24538
Brix, V.L., *See* Cone, B.W., 5:24182
Broce, R.D., *See* Cook, C.W., 5:24571
Brocker, R.W., *See* Fleming, R.B., 5:24534
Bron, J., *See* Barber, D.P., 5:24835
Bronzini, M.S., Freight transportation energy use. Volume I. Summary and baseline results. Final report August 1976-October 1978, 5:24278 (PB—301153)
Freight transportation energy use. Volume II. Methodology and program documentation. Final report August 1976-October 1978, 5:24279 (PB—301154)
Freight transportation energy use. Volume III. Freight network and operations database. Final report August 1976-October 1978, 5:24280 (PB—301155)
Bronzini, M.W., Freight transportation energy use. Volume IV. Analysis of selected energy conservation options. Final report August 1976-October 1978, 5:24281 (PB—301156)
Brookman, K., *See* Thompson, L.H., 5:24710
Brooks, R.D., Multiple-pass carbon dioxide laser heating of a theta-pinch plasma, 5:24990
Brooks, R.L. Jr., Measurement of effective ionization and recombination rate coefficients for intermediate iron ions in a laser generated theta-pinch heated plasma, 5:25008
Brooksbank, R.E., Plenary lecture - a special radioelement problem: ORNL assistance to Three Mile Island in handling contaminated air and water, 5:24083 (CONF-791049—26)
See Armento, W.J., 5:23759
Brookshire, D.S., *See* Ives, B.C., 5:24665
Brookstein, D.S., *See* Cook, F.L., 5:24300
Broussely, M., *See* Jumel, Y., 5:24147
Brown, A., Water management for oil shale mining and retorting in the Piceance Creek Basin, Colorado, 5:23658
Brown, C.D., *See* Habegger, L.J., 5:23847
Brown, C.L., Potentialities of forest biomass as sources of energy, 5:23838 (SRO—1015-T1)
Brown, D.H., Steam injected gas turbine study: an economic and thermodynamic appraisal. Final report, 5:24016 (EPRI-NP—1186)
Brown, K.C., Industrial applications analysis: market characterization and system definition for several industries, 5:23910 (SERI/TP—333-429, pp 81-85)
Brown, L., *See* Reilinger, R., 5:24786
Brown, L.F., Kinetic behavior of subbituminous coal drying: effects of confining pressure, 5:23541 (LA-UR—80-551)
Brown, R.A., Development of nickel-zinc batteries for aircraft, remotely piloted vehicle and missile applications, 5:24137
Brown, R.E., Search for nuclear structure dependence of analyzing powers for the (t,p) reaction in medium mass nuclei, 5:24917
Brown, V.R., *See* Finlay, R.W., 5:24915
Browne, J.C., *See* Wilcke, W.W., 5:24937
Brubaker, J.E., Self locking drive system for rotating plug of a nuclear reactor, 5:24065
Bruce, C.R., Apparatus and method for controlling the rate of feeding a petroleum product to a coking drum system, 5:23591
Bruch, A., An analysis of inspection-maintenance program options for Jefferson County, Kentucky. executive summary. Final report, 5:24606 (PB—299935)
Brucker, E., *See* Brick, D., 5:24854
Bruckner, L.A., *See* Nachtsheim, C.J., 5:23601
Bruemmer, S.M., *See* Thomas, M.T., 5:24407
Brummer, S.B., *See* Abraham, K.M., 5:24153
Bruno, C., *See* Bracco, F.V., 5:23426
Bruyant, F., *See* Brick, D., 5:24854
Bryant, H.C., Solar pond studies: Phase III. Fifth semiannual progress report to the US Department of Energy, 5:23945 (ALO—3977-5)
Bryant, W.A., Iron-air battery characteristics, 5:24114
Bryson, J.W., Determination of K-factors for arbitrarily shaped flaws at pressure vessel nozzle corners, 5:24045 (CONF-791118—11)
Bube, R.H., *See* Courreges, F.G., 5:23824
See Tsai, M., 5:24294
Buckingham, A.C., Modeling propellant combustion interacting with an eroding solid surface, 5:24584 (UCRL—83727)
Buckley, W.M., *See* Mann, L.G., 5:24921
Budgor, A.B., Exact solutions in the scalar diffraction theory of aberrations, 5:24972
Budker G.I., *See* Bel'chenko, Yu.I., 5:24549
Budny, R., Thermal responses of first wall limiters in the Tokamak Fusion Test Reactor, 5:25100
Buffa, A., *See* Holt, J.G., 5:24954
Buffington, J.L., *See* Ritch, G.P., 5:24276
Bugg, W., *See* Brick, D., 5:24854
Bugg, W.M., Investigation of higher-mass even-G states from 15-GeV/c π^+d collisions, 5:24855
Buikman, D., *See* Barber, D.P., 5:24835
Bullion, T.M., Testing and analysis of a fast discharge homopolar machine (fdx), 5:25059
Bulmer, B.M., Pretest thermal analysis of the Tuff Water Migration/In-Situ Heater Experiment, 5:23742 (SAND—79-1278)
Bulos, F., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Bunting, B.G., *See* Johnson, J.H., 5:23569
Bunting, R.K., *See* Ryan, D.M., 5:24128
Bunyan, S., *See* Garcia, A., 5:23811
Buras, A.J., *See* Bialas, A., 5:24857
Burdick, G.R., Operator support through modern optimal estimation and control, 5:24078 (CONF-800627—1)
Burger, J.D., *See* Barber, D.P., 5:24835
Burgess, R.L., Monitoring on rights-of-way and the National Biomonitoring Inventory, 5:24642 (CONF-7910141—1)
Burke, D.L., *See* Himel, T.M., 5:24840
Burke, G.J., Computer modeling of antennas near the ground, 5:24538 (UCID—18626)
Burke, R.J., *See* Arnold, R.C., 5:24551
Burkhalter, P.G., XUV spectra of Mo XIII-XVIII, 5:25002 (NRL-MR—4177)
Burkhart-Schultz, K., *See* Lebo, R.V., 5:24711
Burkle, J., *See* Lamb, R.G., 5:24605
Burnet, G., *See* Murtha, M.J., 5:23466
See Roy, N.K., 5:23542
Burnett, J.A. Jr., TVA project for production of ammonia from coal, 5:23792
Burnett, T., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Burnett, T.A., Impact of ammonia utilization by NOx flue gas treatment processes. Final report August 1977-November 1978, 5:24038 (PB—300596)
Burnetti, J., *See* Racine, D., 5:24784
Burns, A.R., *See* Terner, J., 5:24685
Burns, E.J.T., Soft x-ray vacuum ultraviolet spectroscopy of thin targets heated by enhanced electron energy deposition, 5:24481

Burns, J., The use of waste and low-grade materials in road construction. 6. Spent oil shale, 5:23647 (PB—299940)
Burns, M.M., *See* Pappas, P.G., 5:24813
Burns, R.C., *See* Trice, J.B., 5:23920
Burnstein, R., *See* Brick, D., 5:24854
Burright, B.K., *See* Stucker, J.P., 5:24263
Burstein, P., *See* Petrasso, R., 5:24999
Burt, R., *See* Souder, P.S. Jr., 5:23549
Burt, R.J., Radio frequency magnetron sputtering of thick film amorphous beryllium, 5:24809
Burton, B., *See* Reynolds, G.L., 5:24432
Burton, G.W., *See* Hanna, W.W., 5:24715
Burton, J.K., Inductive storage-prospects for high power generation, 5:25056
See Boller, J.R., 5:25054
Buschman, H.W., *See* Tippets, F.E., 5:24056
Busse, G., *See* Rosencwaig, A., 5:24577
Butler, F.E., *See* Fair, D.H., 5:24610
Butler, M.A., Electrochemical light-emitting diodes, 5:24500
Butler, p.A., *See* Yates, S.W., 5:24922
Butz, T.R., Hydrogeochemical and stream sediment detailed geochemical survey for Laramie Range, Wyoming, 5:23690 (GJBX—100(80))
Buzzelli, E.S., Silver-iron battery performance characteristics, 5:24138
See Bryant, W.A., 5:24114

C

Cagliostro, D.J., *See* Tobin, R.J., 5:24096
Caines, M.J., *See* Kupperman, D.S., 5:24507
Call, P.J., Summary of solar experience with the soiling of optical surfaces, 5:23959 (SERI/TP—334-478)
Callcott, i.A., *See* Petrakian, J.P., 5:24398
Callcott, T.A., *See* Williams, M.W., 5:24412
Callen, R.B., *See* Angevine, P.J., 5:23439
Calvin, M., Green factories, 5:23843
See Bissell, M.J., 5:24714
Camacho, S.L., Method for the gasification of carbonaceous matter by plasma arc pyrolysis, 5:23430
Camaret, T.L., *See* Impellezzeri, J.R., 5:24055
Campbell, E.M., Exploding-pusher-tamper areal density measurement by neutron activation, 5:23761
Campbell, G.W., LLL calibration and standards facility, 5:24573 (UCRL—84295)
Campbell, J.C. Jr., Advanced Coal-Fueled Combustor/Heat Exchanger Technology Study. Research and development plan, 5:24012 (FE—2612-16)
Campbell, M.K., *See* Morse, W.M., 5:24847
Campbell, R.B., *See* Hopkins, R.H., 5:23809, 5:23810
Campillo, A.J., Picosecond fluorescence studies of exciton migration and annihilation in photosynthetic systems. A review, 5:24693
Campo, J.G. Del, *See* Cordell, K.R., 5:24900
Campos, I.M., Concurrent software system design supported by SARA at the age of one, 5:25102
SARA aided design of software for concurrent systems, 5:25103
Campoy, L.P., *See* Smith, S.E., 5:23916
Canon, R.M., Engineering analysis and comparison of new processes for the recovery of resource materials from coal ash, 5:23465 (METC/SP—79/10(Pt.1), pp 56-67)
See Seeley, F.G., 5:23470
Canonico, D., Pressure vessel safety: the story of the ASME code, 5:24533
Caporaso, G., *See* McClellan, G., 5:24951
Caram, H.S., *See* Schiesser, W.E., 5:23423
Carbajo, J.J., Plenum-2A, a program for transient analysis of liquid-metal fast breeder reactor outlet plenums, 5:24062
Carciello, N., *See* Zeldin, A., 5:24439, 5:24444
Card, H.C., *See* Ng, K.K., 5:24473
Cardello, T., *See* Sandweiss, J., 5:24851
Carew, J.F., Relating surveillance capsule measurements to pressure vessel damage, 5:24073 (BNL-NUREG—27192)
Carey, D., Kaiparowits handbook, coal resources (Lake Powell Research Project, interim report), 5:23534 (PB—301108)
Carithers, W.C., *See* Himel, T.M., 5:24840
Carley, J.F., *See* Ackerman, F.J., 5:23639
Carlos, W.E., Band structure and thermodynamic properties of He atoms near a graphite surface, 5:24471
Carls, E.L., *See* Johnson, I., 5:23558
Carlson, D.J., *See* Johnson, J.H., 5:23569
Carlson, J.B., *See* Mann, L.G., 5:24921
Carlson, R.V., Preliminary analysis of the safety and environmental impact of the Tritium Systems Test Assembly, 5:25068 (LA-UR—80-1249)
Carlton, R., Solar tracking system for line focusing collectors, 5:23955 (SERI/TP—333-429, pp 87-89)
Carnegie, E.J., Analysis of the operation of an industrial drying solar system, 5:23921 (SERI/TP—333-429, pp 205-213)
Carpenter, B.H., *See* Baldwin, V.H., 5:24315
Carpenter, J.M., *See* Das, S.G., 5:24952
Carpenter, R., *See* Robertson, D.E., 5:24485
Carr, P., 50 kW-hr zinc-chlorine hydrate battery, 5:24106
Carr, W.W., *See* Cook, F.L., 5:24300
Carrano, A.V., *See* Lebo, R.V., 5:24711
Carrier, R.F., Entrainment, 5:24761
Carrigan, F.J., *See* Harris, D.P., 5:23673
Carroll, A.S., *See* Bionta, R.M., 5:24852
Carroll, D.W., *See* McCreary, W.J., 5:24453
Carroll, J., *See* Ashby, J.B., 5:23469
Carroll, W., *See* Place, W., 5:23886
Carstens, D.H.W., Ionization chamber for measurements of high-level tritium gas, 5:24489 (LA-UR—80-1215)
Carter, G.W., Unique rod lens/video system designed to observe flow conditions in emergency core coolant loops of pressurized water reactors, 5:24048 (UCRL—52902)
Carter, W.C., *See* Cook, F.L., 5:24300
Carver, J.H., *See* Adair, G.M., 5:24764
Cary, J.R., Production of plasma from diatomic gases by relativistic electron beams, 5:25022
Wave-energy density and wave-momentum density of each speciesof a collisionless plasma, 5:25038
Case, C.M., Thermodynanmic relations between selected parameters describing unsaturated flow, 5:24780 (DOE/DP/01253—18)
Case, G.N., *See* McDowell, W.J., 5:24559
Case, R.W., Shock absorber for oil well pumping unit, 5:23584
Casey, A.W., *See* Landingham, R.L., 5:24425
Casper, T.A., *See* Grubb, D.P., 5:25006
Cassedy, E.S., Solar-industrial heat for New York State: a case study in regional impact on economic viability, 5:23911 (SERI/TP—333-429, pp 91-95)
Cassmassi, J., *See* Horie, Y., 5:24613
Casten, R.F., *See* Cizewski, J.A., 5:24932
Catalano, A., *See* Wyeth, N.C., 5:24474
Cates, M., *See* Cindro, N., 5:24909
Cathers, A.R., *See* Petrakian, J.P., 5:24398
Catton, I., *See* Somerton, C.W., 5:23978
Cavagnaro, D.M., Carbon dioxide lasers. Volume 3. 1976-1977 (a bibliography with abstracts). Report for 1976-77, 5:24523 (NTIS/PS—79/1067)
Electrostatic precipitators. Volume 2. 1975-1977 (citations from the Engineering Index Data base). Report for 1975-77, 5:24544 (NTIS/PS—79/1035)
Nitrogen oxide air pollution. Part 1. Control technology. volume 2. 1975-1977 (a bibliography with abstracts). Report for 1975-77, 5:24545 (NTIS/PS—79/1056)
Nitrogen oxide air pollution. Part 1. Control technology. Volume 3, 1978-August, 1979 (a bibliography with abstracts). Report for 1978-August 1979, 5:24546 (NTIS/PS—79/1057)
Nitrogen oxide air pollution. Part 2. Detection and analysis. Volume2. 1976-August, 1979 (a bibliography with abstracts). Report for 1976-August 1979, 5:24595 (NTIS/PS—79/1058)
Nitrogen oxide air pollution. part 3. atmospheric chemistry (a bibliography with abstracts). Report for 1964-August 1979, 5:24596 (NTIS/PS—79/1059)
Nitrogen oxide air pollution. Part 5. Emissions studies. Volume 2. 1975-1977 (a bibliography with abstracts). Report for 1975-77, 5:24597 (NTIS/PS—79/1061)
Nitrogen oxide air pollution. Part 5. Emissions studies. Volume 3. 1978-August, 1979 (a bibliography with abstracts). Report for 1975-August 1979, 5:24598 (NTIS/PS—79/1062)
Nitrogen oxide air pollution. part 4. Biological effects (a bibliograhy with abstracts). Report for 1964-August 1979, 5:24777 (NTIS/PS—79/1060)
Cavalli-Sforza, M., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Cave, L., CANVEY: the reaction of a community exposed to substantial risks, 5:24662 (ALO—80)
Tentative outline of work scope and organization for a study of the risks from energy production in the US, 5:24080 (ALO—81)
Cecchi, J.L., Transient getter scheme for the Tokamak Fusion Test Reactor, 5:25099
Chamberlin, E.P., *See* Winkelmann, E., 5:24891
Champeix, L., *See* Aubeau, R., 5:24493
Chance, B., *See* McLaughlin, A.C., 5:24697
Chance, M.S., *See* Dewar, R.L., 5:25026
Chandlee, C., *See* Berg, D., 5:24841
Chang, C.C., *See* Barber, D.P., 5:24835
See Heisterberg, R.H., 5:24848
Chang, J., *See* Burns, E.J.T., 5:24481
Chapman, S., On the Hill: energy muddlization, 5:24208
Chappell, W.R., DOE/EV Task Force on the environmental and health effects of modified in situ oil shale processes, 5:23649
Toxic trace elements and oil shale production, 5:23656
Trace element release and transport associated with shale oil production, 5:23665
Charkey, A., Silver-hydrogen cells, 5:24113
Chartock, M.A., *See* White, I.L., 5:23668
Chau Wang, L.C., Flavor mixing and charm decay, 5:2486! (BNL—27615)
Chauhan, S.P., *See* Droege, J.W., 5:23451
Chaurey, K.H., Coal-based ammonia plants: preliminary operating experience of coal gasification at Talcher and Ramagundam fertilizer

plants of The Fertilizer Corporation of India, 5:23788
Chauvel, B., *See* Durand, J.P., 5:23596
Chauvin, G., Electrochemical generator based upon molten fluorides, 5:24105
Chen, F.C., Thermally driven open-cycle heat pump system, 5:24306 (CONF-800549—1)
Chen, H.C., *See* Sullivan, R.F., 5:23446
Chen, H.S., *See* Barber, D.P., 5:24835
Chen, H.T., *See* Ahn, Y.K., 5:23835
Chen, L.J., *See* Wu, W., 5:24384
Chen, L.L., *See* Solbrig, C.W., 5:24081
Chen, S., Photoelectrochemical cell, 5:23845
Chen, Y.C., *See* Ahn, Y.K., 5:23835
Cheng, R.J., *See* Mohnen, V.A., 5:24619
Cherne, J., Solar production of industrial process steam for potato frying, 5:23935 (SERI/TP—333-429, pp 335-342)
Chernick, M.R., Note on the robustness of Dixon's ratio test in small samples, 5:25111 (ORNL/TM—7265)
Chestnut, R., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Chevion, M., Favism inducing agents: a pulse radiolysis study of isouramil and convicine, 5:24735 (DOE/EV/03221—63)
Quaternay structure and spin state of human fetal methemoglobin. Progress report, September 1, 1979-July 1, 1980, 5:24670 (DOE/EV/03221—65)
See Ilan, Y.A., 5:24733
Chi, C.H., *See* Carr, P., 5:24106
Chien, C., *See* Brick, D., 5:24854
Child, E.T., Current status of the Texaco coal gasification process, 5:23785
Ching, J., *See* Reier, M., 5:23706
Chinowsky, W., *See* Himel, T.M., 5:24840
Chireau, R.F., Development of subminiature lithium-monofluorographite-organic electrolyte primary cells, 5:24117
Chivers, T.C., *See* Gordelier, S.C., 5:24418
Cho, B.S., *See* Cirillo, R.R., 5:23850
Chodos, A., Simple connection between conservation laws in the Korteweg—de Vriesand sine-Gordon systems, 5:24877
Chopra, S.K., Research and utilization of Indian fly ashes in cement manufacture: an overview, 5:23492 (METC/SP—79/10(Pt.2), pp 631-652)
Chou, T.S., *See* Skelton, R., 5:24535
Christensen, B.Y., *See* Bard, F.E., 5:24093
Christensen, C., *See* Place, W., 5:23886
Christensen, E.L., Plutonium recovery at the Los Alamos Scientific Laboratory, 5:23720 (LA-UR—80-1168)
Christensen, R., Solar air systems for space heating, 5:23894
Christensen, S.W., Best approach to impact assessment is to use empirically based or simulation models to forecast impacts. Environmental Sciences Division Publication No. 1538, 5:24024 (CONF-800543—2)
Christian, W.J., Special reporter comments and questions, 5:24441 (EPRI-EL—1263, pp 7.1-7.4)
Christianson, A., *See* Thoem, T., 5:23669
Christopulos, J.A., *See* DiMasi, G.J., 5:24168
Chu, K.R., *See* Gilgenbach, R.M., 5:24988
See Ott, E., 5:24984
Chu, S.N.G., Photoelastic studies of three-dimensional stress field caused by a cylindrical punch, 5:24532
Chu, T.C., Cyclotron radiation by a multi-group method, 5:25011 (COO—2218-160)
Chua, D.I., Large lithium-thionyl chloride cells: cell performance and safety, 5:24151
Chung, M.S., *See* Williams, M.W., 5:24412
Chupriyanov, V.E., *See* Bel'chenko, Yu.I., 5:24549
Chye, P.W., *See* Skeath, P., 5:24381
Chynoweth, D.P., Anaerobic digestion of marine biomass, 5:23840
Cihangir, S., *See* Berg, D., 5:24841
Cindro, N., Resonances in ^{36}Ar via the ^{24}Mg(^{12}C, α)^{32}S reaction, 5:24909
Cirillo, R.R., Comparative analysis of net energy balance for satellite power systems (SPS) and other energy systems, 5:23850 (DOE/ER—0056)
See Levine, E.P., 5:23849
Cizewski, J.A., Level structure of ^{196}Pt, 5:24932
See Brown, R.E., 5:24917
Clark, D.D., *See* Gunderson, J., 5:24352
Clark, E.C., Sulfuric acid and water chemical heat pump/chemical energy storage program. Phase II-A. Final report, 5:23892 (SAND—78-8176)
Clark, E.L., Coal gasification: the state of the art, 5:23432
Clark, J.L., *See* Cook, F.L., 5:24300
Clark, N., *See* Jackson, K.L., 5:23990
Clarke, J., *See* Gamble, T.D., 5:24788
See Goubau, W.M., 5:24790
See Voss, R.F., 5:24516
Clauser, J.F., *See* Grubb, D.P., 5:25006
Clausing, R.E., Fifteen-centimeter-diameter UHV transfer system for remote plasma-wall interaction experiments, 5:25094
Clayton, R.K., *See* Ohad, I., 5:24677
See Rafferty, C.N., 5:24682
Cleaver, J.E., Xeroderma pigmentosum variants have a slow recovery of DNA synthesis after irradiation with ultraviolet light, 5:24743
Clem, J.R., Application of low-temperature scanning electron microscopy to superconductors, 5:24514
Cline, D., *See* Yates, S.W., 5:24922
Cocks, F.H., Optical band gap of hydrogenated amorphous-boron thin films: The effect of thermal treatment, 5:24454
Coensgen, F.H., *See* Grubb, D.P., 5:25006
Coester, F., *See* Betz, M., 5:24945
Cohen, B.I., Simulation of drift-cone modes, 5:25029
Cohen, G.S., *See* Zabinski, R.J., 5:24640
Cohen, J.B., Vapor emission recovery and measuring method and vapor recovery collection boot, 5:24626
Cohen, M.H., *See* Arai, T., 5:24960, 5:24961
Cohen, M.L., *See* Ihm, J., 5:24963
Cohen, N., Metabolism of americium-241 in man: an unusual case of internal contamination of a child and his father, 5:24752 (COO—3382-18, pp III.1-III.12)
Microdistribution of ^{243} ^{4}Cm in the ovary of an adult baboon, 5:24758 (COO—3382-18, pp IV.1-IV.6)
Radioactivity studies progress report, 5:24755 (COO—3382-18)
See Lipsztein, J., 5:24753
See Neton, J., 5:24759, 5:24760
See Sasso, T.L., 5:24756, 5:24757
Cohen, S.A., *See* Cecchi, J.L., 5:25099
See Dylla, H.F., 5:25097
See Razdow, A.M., 5:25101
See Voss, D.E., 5:24994, 5:25000
See Wampler, W.R., 5:25004
Cohen, S.M., Effects of ethanol on alanine metabolism in perfused mouse liver studied by ^{13}C NMR, 5:24717
Cohn, H.O., *See* Brick, D., 5:24854
See Bugg, W.M., 5:24855
Colavita, E., *See* Rosei, R., 5:24401
Colburn, J.W. Jr, *See* Wood, C.D., 5:24520
Cole, J.L., In situ combustion of Antrim oil shale: field test of Tejas petroleum engineers burner, 5:23626 (FE—2346-48)
Cole, M.W., *See* Carlos, W.E., 5:24471
Coleman, A.J., *See* Walker, G.W., 5:24239
Coleman, J.J., Development of a site-fabricated, building integrated air collector. Quarterly technical progress report, September 30, 1977-December 31, 1977, 5:23947 (ALO—4123-T2)
Coleman, W.H., *See* Westerberg, A.W., 5:23863
Colemen, J.J., *See* Kohler, J.T., 5:23948
Coles, M.W., *See* Himel, T.M., 5:24840
Collins, A.G., *See* French, T.R., 5:23578
Collins, C., *See* Hulman, P., 5:24587
Collins, L.W., Thermal and electrostatic initiation of TiH/sub x/ based pyrotechnics, 5:24582 (MLM—2710(OP))
See Moddeman, W.E., 5:24580
Collins, M.F., Removal of tritium and tritium-containing compounds from a gaseous stream, 5:23764
Colombani, a., *See* Yates, S.W., 5:24922
Colombant, D.G., Hard x-ray spectrum from a one-fluid laser plasma model, 5:25014 (NRL-MR—4241)
Combs, L.P., High efficiency furnace with low pollution emissions, 5:24259
Comfort, J.R., *See* Finlay, R.W., 5:24915
Condit, W.C., *See* Fowler, T.K., 5:25046
Condo, G., *See* Brick, D., 5:24854
Condo, G.T., *See* Bugg, W.M., 5:24855
Cone, B.W., Analysis of federal incentives used to stimulate energy production: an executive summary, 5:24182 (PNL—2410(Rev.2))
Conrad, G.E., *See* Virchow, C.F., 5:24586
Conrad, J.R., Enhanced neutral-beam divergence due to imperfect magnetic shielding, 5:24574
Conte, D., *See* Burton, J.K., 5:25056
Cook, C.W., Bell Canyon Test (BCT) instrumentation development, 5:24571 (SAND—80-0408C)
Cook, F.L., Energy conservation in the textile industry. Phase II. Final report, June 1977-August 1978, 5:24300 (ORO—5099-T2)
Cook, J.R., *See* Thayer, P.A., 5:23683
Cook, R.J., Quantum-mechanical fluctuations of the resonance-radiation force, 5:24883
Cooper, D.B., *See* Dunlop, J.D., 5:24132
Cooper, J.W., *See* Jacobs, V.L., 5:24828
Cooper, P., *See* Sandweiss, J., 5:24851
Cooper, P.W., *See* Austing, J.L., 5:24583
Cooper, S., *See* Himel, T.M., 5:24840
Copenhaver, E.D., Spatial data on energy, environmental, health, and socio-economic themes at Oak Ridge National Laboratory: 1979 inventory, 5:24175 (ORNL—5636)
Coppi, B., Self-healing of confined plasmas with finite pressure, 5:24986
Corbin, L.T., *See* Laing, W.R., 5:24488
Cordell, K.R., ^{12}C(^{13}C, α)^{21}Ne reaction. High-spin states, resonances and coherence widths, 5:24900
Coriou, H., *See* Chauvin, G., 5:24105
Corlett, R.C., *See* Brown, L.F., 5:23541
Corliss, J.M. II, Passive environmental temperature control system, 5:23874
Cornils, B., Status of the Texaco coal dust gasification operating in the Ruhrchemie/Ruhrkohle demonstration plant at Oberhausen-Holten, 5:23437
Correll, D.L., *See* Grubb, D.P., 5:25006
Corvitti, J., Evaluation of particulate emission factors for vehicle tire wear. Final report, 5:24609 (PB—300443)
Cosman, E.R., ^{12}C+^{12}C intermediate structures correlated among elastic and reaction channels, 5:24894
Costello, D., *See* Posner, D., 5:23853
Costello, J., Health studies of oil shale workers, 5:23654
Costello, V.A., Heat transfer and calorimetric studies of a direct

contact-latent heat energy storage system, 5:23977
Courreges, F.G., Sputtered indium-tin oxide/cadmium telluride junctions and cadmium telluride surfaces, 5:23824
Courtois, J.C., *See* Bailly-Lacresse, J.G., 5:23589
Cowan, M.J., Evaluation of comparative toxicity and shipboard hazards of selected petroleum and oil shale-derived fuels, 5:23655
Cowan, R.D., *See* Burkhalter, P.G., 5:25002
Cowen, D.S., Optimization technique for minimizing the cost of self-powering industrial HVAC systems, 5:24304
Cox, A.N., Theoretical period ratios for RR Lyrae variables and AQ Leonis, 5:24795
Cox, D., Potential industrial applications for fluidized-bed waste heat recovery systems, 5:24308 (DOE/CS/40255—1)
Cox, K.C., Experiences in equipping a 96-inch-diameter shaft, and mining bulk samples of oil shale, dawsonite and nahcolite, 5:23621
See Vinson, R.P., 5:23653
Cox, L.E., Control system considerations for an aluminum-air battery powered electric vehicle. Final report, 5:24348 (UCRL—15241)
Cox, S.H., *See* Barnhart, B.J., 5:24739
Coyle, R.T., Properties of a solar alumina-borosilicate sheet glass, 5:23960 (SERI/TP—334-565)
Coyne, D., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Crabb, J.O., *See* Chua, D.I., 5:24151
Crabtree, G.W., *See* Lowndes, D.H., 5:24402
Craig, T., *See* Moss, G., 5:24506
Craig Miller, H., Obtaining numerical values for the elliptic emission functions used in calculating electron emission from surfaces, 5:24957
Cramer, J.G., *See* Zisman, M.S., 5:24903
Crandall, D.H., *See* Gardner, L.D., 5:24824
Crandall, J.L., High level nuclear waste, 5:23717 (DP-MS—80-39)
Crandall, R.S., Band-tail absorption in hydrogenated amorphous silicon, 5:24477
Crane, S.D., *See* Fitzgerald, T.J., 5:23560
Crawley, R.L., Fusion target evaluation by buoyancy analysis, 5:23762
Creutz, M., Monte Carlo study of quantized SU(2) gauge theory, 5:24881
See Bhanot, G., 5:24879
Crhistensen, R.B., *See* Lawrence, C.W., 5:24745
Cronin, R.H., *See* Henderson, C., 5:24271
Crookston, R.B., Potential for fires and explosions in oil shale mining and processing, 5:23652
Crosby, E.C., *See* Overton, D.E., 5:23518
Crowley, J.L., *See* Jonath, A.D., 5:23807
Crowther, D., Protonmotive cyclic electron flow around photosystem I in intact chloroplasts, 5:24686
Crozier, E.D., *See* Ingalls, R., 5:24465
Cseh, J., *See* Sanders, S.J., 5:24905
Cullen, D.N., A study of the permanent effects of elevated temperature on the hydraulic properties of clay. Master's thesis, 5:24463 (PB—300686)
Culley, R.W., Performance of waste coal ash as highway subbase course, 5:23500 (METC/SP—79/10(Pt.2), pp 758-778)
Cumalat, J.P., Recent results in photoproduction, 5:24836
Cumiskey, P.L., *See* Mendis, M.S., 5:23537
Cummins, W.F., *See* Grubb, D.P., 5:25006
Curtin, M.S., Commercial development considerations, 5:23712
Curtis, B., *See* Place, W., 5:23886
Curtis, D.B., *See* Gladney, E.S., 5:23532
Cusson, R.Y., Prediction of heavy element fission barrier features for multiple chance neutron cross-section calculations, 5:24927 (UCRL—84370)
Cverna, F.H., *See* Winkelmann, E., 5:24891
Czapski, G., *See* Chevion, M., 5:24670
See Ilan, Y.A., 5:24733
See Jacobs, G.P., 5:24744
See Samuni, A., 5:24734

D

D'Souza, A.F., *See* Aronov, V., 5:24509
Dabkowski, M.J., *See* Angevine, P.J., 5:23439
Dagenhart, W.K., *See* Kim, J., 5:24987
Dahl, M.C., *See* Vaughn, J.M., 5:24727
Dahlby, J.W., *See* Baughman, W.J., 5:24486
Dahle, D.B., Analysis of the effects of chemical and physical mutagens on subchromosomal DNA synthesis in cultured mammalian cells, 5:24736 (UR—3490/LCP-20)
Dand, P.V., Studies on some non-standard systems for thermal battery applications, 5:24107
Daneshvar, K., *See* Prosser, F.W. Jr., 5:24906
Dang, V.D., *See* Steinberg, M., 5:23768
Daniel, B.E., *See* VanOsdell, D.W., 5:24031
Daniels, E.J., *See* Cowen, D.S., 5:24304
Daniels, W.R., *See* Orth, C.J., 5:24914
Danielson, E., Diesel hydrocarbon measurement - series filter test. Technical report, 5:24356 (PB—301410)
Dannenberg, R.O., Preparation of hydrosulfides, 5:24456
Dao, K., Development of solar driven absorption air conditioners and heat pumps, 5:23888 (LBL—10771)
Darby, L.B., Method and apparatus for recovery of subsea well equipment, 5:23582
Darley, E.F., Hydrocarbon characterization of agricultural waste burning. Final report, 5:24615 (PB—300916)
Das, S.G., Slow neutron leakage spectra from spallation neutron sources, 5:24952 (ANL—80-27)
DasGupta, A., *See* Kroeger, D.M., 5:24404
Daugherty, J.W., Numerical simulation of magnetically confined plasmas undergoing cyclotron resonance heating, 5:24991
Davey, H.L., *See* Britt, J.F., 5:23962
David, W.R., *See* Carstens, D.H.W., 5:24489
Davidson, D.M. Jr., Investigations of the uranium potential along the Proterozoic unconformity in the Van Horn Areas, Texas. Final report, 5:23688 (GJBX—97(80))
Davidson, J.W., *See* Parish, T.A., 5:25071
Davidson, W.F., *See* Cizewski, J.A., 5:24932
Davis, C.H., TVA-NFDC role in fertilizer development, 5:23779
Davis, D., Analysis of iron content in individual human red blood cells by electron microprobe and scanning electron microscope, 5:24719
Davis, D.T., *See* Lytle, R.J., 5:24787
Davis, H.L., Structure of the clean Re(1010) surface, 5:24379
See Noonan, J.R., 5:24408
Davis, J., *See* Jacobs, V.L., 5:24828
See Kaellne, J., 5:24889
See Rozsnyai, B.F., 5:24996
Davis, J.C., *See* Grubb, D.P., 5:25006
Davis, J.P., *See* Dunlay, J.B., 5:24336
Davis, J.R., *See* Hopkins, R.H., 5:23809, 5:23810
Davis, M.S., Ligated chlorophyll cation radicals: their function in photosystem II of plant photosynthesis, 5:24680
Ligated chlorophyll cation radicals: their function in photosystem II of plant photosynthesis, 5:24681
Davis, R.C., *See* Kim, J., 5:24987
Davis, R.L., *See* Akutagawa,W.M., 5:24721
Davis, R.R., Luminescent solar collector, 5:23826
Davis, S.P., *See* Galehouse, D.C., 5:24816
Davitian, H., *See* Bright, R., 5:23877
Dawans, F., *See* Durand, J.P., 5:23596
Day, R.H., *See* Whitman, R.L., 5:25079
De, G.S., Microscopic theory of thermal desorption and dissociation processes catalyzed by a solid surface, 5:24959
de Bucs, E.S., *See* Kuesebauch, W., 5:23771
de Jong, C., *See* Noomen, A., 5:24503
de Saint Simon, M., *See* Morrissey, D.J., 5:24926
De Voto, R.H., Uranium exploration, 5:23698
Deal, R.M., Some observations on a paraffin-wax phase change experiment, 5:24100 (CONF-791108—24)
Deans, H.A., Single-well chemical tracer test simulator handbook: improved accuracy and interpretation for residual oil saturation measurement, 5:23573 (DOE/BC/20006—14)
Deb, S.K., *See* Chen, S., 5:23845
DeBiccari, D., *See* Holleck, G.L., 5:24135
Decker, C.E., *See* Eaton, W.C., 5:24614
Decoste, R., High-energy ion expansion in laser-plasma interactions, 5:25023
See Ripin, B.H., 5:25082
Deffenbaugh, D.M., Solar production of industrial process steam for the Lone Star Brewery, 5:23933 (SERI/TP—333-429, pp 321-325)
DeGrasse, R. Jr., Shifting MX expenditures to energy efficiency: memo on the national security implications of alternative energy development, 5:24192 (CEP-OP—0-2)
DeGruson, J.A., Thermal battery improvements, 5:24127
DeHart, G., *See* Anderson, J.H., 5:24599
Delaney, J.B., State of competition in gasoline marketing. The effects of refiner operation at retail (a study required by Title III of the Petroleum Marketing Practices Act), 5:23600 (DOE/PE—0019(Vol.1))
Delene, J.G., ACFAC: a cash flow analysis code for estimating product price from an industrial operation, 5:24069 (ORNL/TM—7150)
Dell, R.M., *See* Markin, T.L., 5:24164
DeLuca, H.F., Regulation of vitamin D metabolism in the kidney, 5:24694
DeLuca, W.H., System and method for charging electrochemical cells in series, 5:24154
Delwiche, P., Evaluation of ash storage sites: a case history, 5:23479 (METC/SP—79/10(Pt.1), pp 357-404)
DeMeo, E., *See* Nesbit, W., 5:24002
Dennis, B.R., Borehole survey instrumentation development for geothermal applications, 5:23988 (LA-UR—80-670)
Dennis, L.C., *See* Cordell, K.R., 5:24900
Dent, J.K., CEGB overview, 5:23461 (METC/SP—79/10(Pt.1), pp 29-33)
Derevyankin, G.E., *See* Bel'chenko, Yu.I., 5:24549
deRosset, A.J., *See* Riedl, F.J., 5:23447
Derr, K.W., Packet switching, 5:25109 (EGG—2015)
Desai, S.A., Overview of critical issues in coal transportation systems, 5:23545
Deshpande, S.L., *See* Chua, D.I., 5:24151

DeSieghardt, W.C., *See* Harris, H.E., 5:23523
Deutsch, O.L., *See* Thompson, W.L., 5:24057
DeVries, R.M., *See* Zisman, M.S., 5:24903
Dew-Hughes, D., Effect of neutron irradiation upon the superconducting critical temperature of some transition-metal carbides, nitrides, and carbonitrides, 5:24434
Dewar, R.L., N-dependence of ballooning instabilities, 5:25026 (PPPL—1663)
See Bhattacharjee, A., 5:25017
DeWitt, H.E., *See* Slattery, W.L., 5:24975
Dey, A.N., Primary Li/$SOCl_2$ cells. VI. Identification of the possible explosion causing cell constituents by DTA studies, 5:24152
Diamond, R.M., *See* Yates, S.W., 5:24922
Diamond, S., *See* Rowcliffe, A.F., 5:24372
Dick, D.L., *See* Skogerboe, R.K., 5:23666
Dickens, J.K., Fission product decay heat for thermal reactors, 5:24084 (CONF-791058—71)
Dickinson, W.C., Economic analysis of solar industrial process heat systems: a methodology to determine annual required revenue and internal rate of return, 5:23940 (SERI/TP—333-429, pp 439-444)
Review of four DOE-sponsored solar dehydration systems, 5:23906 (SERI/TP—333-429, pp 33-39)
Dicus, D.A., Background to neutrino counting in e^+e^- collisions, 5:24859
Dienes, G.J., *See* Johnson, R.A., 5:24400
See Klaffky, R.W., 5:24438
See Paskin, A., 5:24964
Dietderich, D., *See* Hong, M., 5:24515
Dieterle, W.E., *See* Himel, T.M., 5:24840
DiGioia, A.M. Jr., *See* Delwiche, P., 5:23479
Dillard, J.G., *See* Squires, A.M., 5:23448
Dillon, J.B., *See* Himel, T.M., 5:24840
DiMasi, G.J., Effects of the electrochemical design upon the safety and performance of the lithium-sulfur dioxide cells, 5:24168
Dimmey, L.J., *See* Cocks, F.H., 5:24454
Dimmock, F.E., *See* Eaton, W.C., 5:24614
Dimov, G.I., *See* Bel'chenko, Yu.I., 5:24549
DiRienzo, A.C., New isotope ^{199}Rn and evidence for an isomeric state ^{199}Rn/sup m/, 5:24929
Dissinger, G.R., *See* Schiesser, W.E., 5:23423
Dixmier, J., *See* Chauvin, G., 5:24105
Dodd, D., *See* Barnhouse, L., 5:24180
Doernberg, A.B., *See* Mubayi, V., 5:24200
Doherty, R.A., *See* Keller, C.A., 5:24772
Dolezal, H., *See* Dannenberg, R.O., 5:24456
Domeniconi, M.J., Lithium thionyl chloride high rate reserve cells, 5:24121
Dominguez, R.R., *See* Waltz, R.E., 5:25040
Domm, T.C., *See* Clausing, R.E., 5:25094
Donnelly, J.J. Jr., Study of hydrogen-powered versus battery-powered automobiles, 5:24340 (ATR—79(7759)-1(Vol.3))
Study of hydrogen-powered versus battery-powered automobiles, 5:24341 (ATR—79(7759)-(Vol.2))
Donoghue, J.F., Pion and an improved static bag model, 5:24870
Doolen, G.D., *See* Slattery, W.L., 5:24975
Doonan, F., *See* Keefer, R.F., 5:23517
Doptis, L.E., *See* Cowan, M.J., 5:23655
Doran, R.J., Batteries for auxiliary electrical supplies in aircraft, 5:24172
Dorenbosch, J., *See* Himel, T.M., 5:24840
Dorfan, J., Recent results from the Mark II detector at SPEAR, 5:24837
Dorfan, J.M., *See* Himel, T.M., 5:24840
Dorn, H.C., *See* Squires, A.M., 5:23448
Doschek, G.A., *See* Burns, E.J.T., 5:24481
Doscher, T., Carbon dioxide for the recovery of crude oil: a literature search to June 30, 1979. Final reportp, 5:23577 (DOE/BETC/5785—1)
Doss, K.G.R., Pion absorption processes, 5:24896 (COO—3244-72)
Dougherty, M.T., *See* McLean, E.T., 5:23516
Douglas, K.E., *See* Wang, J.L.F., 5:24362
Down, D., *See* Liaw, M., 5:23816
Downward, J.G., SYSLOG: an accounting and performance measurement system for RSX11M V3.2, 5:25073 (KMSF-U—970)
Dozy, A.M., *See* Lebo, R.V., 5:24711
Draffin, C.W., Factors affecting US coal use in the next two decades, 5:23544
Drake, D.M., *See* Cindro, N., 5:24909
Drake, R.P., *See* Grubb, D.P., 5:25006
Dreicer, H., *See* Massey, R.S., 5:25013
Dresner, L., Eddy current heating of irregularly shaped plates by slow ramped fields, 5:25048 (CONF-791102—167)
Dreves, W., *See* Egelhof, P., 5:24892
Drianis, G.C., *See* Akutagawa, W.M., 5:24721
Driga, M.D., *See* Bullion, T.M., 5:25059
Drivers, E.F., Sideboard device for improved face ventilation in coal mines. Technical progress report, 5:23568 (PB—300365)
Droege, J.W., Thermophysical properties of coal liquids. Second quarterly technical status report, January 1-March 31, 1980, 5:23451 (BMI—2053)
Droege, T., *See* Berg, D., 5:24841
Dropesky, B.J., *See* Orth, C.J., 5:24914
Druce, R.L., Numerical analysis of high power laser propagation in magnetized plasmas, 5:25037
Drury, D.M., *See* Kiehl, R.A., 5:24570
DuBow, J., Effects of mositure and organic content on the thermophysical properties of Green River oil shale, 5:23646
See Smith, P., 5:23823
Duckett, E.J., Refractory particles in cullet recovered from municipal refuse. Technical report, 5:24328 (PB—300523)
Ducot, E.R., *See* Levis, A.H., 5:24298
Dudek, M, Method of producing petroleum coke calcinate, 5:23592
Dudney, C.S., *See* Griffin, G.D., 5:24762
Dudnikov, V.G., *See* Bel'chenko, Yu.I., 5:24549
Duffy, J.V., *See* Angres, I.A., 5:24166
Dunbar, F.C., *See* Stucker, J.P., 5:24263
Duncan, R.T., Economic viability of the solar-assisted industrial heat pump system, 5:23912 (SERI/TP—333-429, pp 97-102)
Dunlay, J.B., Economic and technological assessment of diesel engines using coal-based fuels for electric power generation. Final report, 5:24336 (TE—4234-37-80)
Dunlop, J.D., INTELSAT IV Ni-Cd battery orbital performance, 5:24132
Dunn, B., *See* Breiter, M.W., 5:24159
Dunn, E.D., *See* van Dyck, O.B., 5:24553
Dunn, W.C., Inhibition of DNA excision repair in human cells by Arabinofuranosyl cytosine: effect on normal and xeroderma pigmentosum cells, 5:24688
Durand, J.P., Grafted copolymers and their use as additives for lubricating oils, 5:23596
Durham, I., *See* Barnhouse, L., 5:24180
Dussman, M., *See* Witkin, R., 5:23981
Dybkjaer, I., Carbon monoxide shift catalysts and carbonyl sulfide hydrolysis catalysts, 5:23435
Dylla, H.F., Glow discharge conditioning of the PDX vacuum vessel, 5:25097
Review of the wall problem and conditioning techniques for tokamaks, 5:25091 (PPPL—1666)
See Razdow, A.M., 5:25101
See Staib, P., 5:25098
See Wampler, W.R., 5:25004
Dzurinko, E., *See* Lechnick, W., 5:23473
Dzurinko, E.P., Field retention time studies of ash settling ponds, 5:23474 (METC/SP—79/10(Pt.1), pp 274-293)

E

Eads, B.G., Development of impedance sensors at ORNL: for measurement of two-phase flows, 5:24085 (CONF-791118—10)
Earl, M.W., *See* Dunlop, J.D., 5:24132
Easley, S.M., *See* Stevens, R.D., 5:24343
Easley, T.L., *See* Stevens, R.D., 5:24343
Eastman, J.M., Method and apparatus for timing of laser beams in a multiple laser beam fusion system, 5:25072
Eastman, S.E., Circuity and the energy-intnsiveness of inland waterway and rail freight transport systems: a progress report, 5:23553
Easton, D.S., Prediction of the stress state in Nb_3Sn superconducting composites, 5:24397
See Kroeger, D.M., 5:24404
Eaton, M.W., *See* Himel, T.M., 5:24840
Eaton, W.C., Study of the nature of ozone, oxides of nitrogen, and nonmethane hydrocarbons in Tulsa, Oklahoma. Volume I. project description and data summaries, 5:24614 (PB—300481)
Eberle, M.K., *See* Dunlay, J.B., 5:24336
Ebner, W.B., Corrosion: a major failure mode of Li/V_2O_5 cells, 5:24146
Eby, R.J., Pipeline gas demonstration plant. Phase I. Quarterly technical progress report, September-November 1979, 5:23422 (FE—2012-083)
Eccli, S.F., Community planning for home-heating emergencies: a guide for Community-Action Agencies and other community-based organizations, 5:24251 (CSA-PAMPHLET—6143-15)
Ecklund, S., *See* Sandweiss, J., 5:24851
Eckstrom, D.J., Determination of spatial energy deposition in e-beam-pumped laser cells by pressure measurements, 5:24527
Edelstein, R.M., *See* Bionta, R.M., 5:24852
Edeskuty, F.J., dc Superconducting Power Transmission Line project at LASL: US DOE Division of Electric Energy Systems. Progress report No. 24, November 1, 1972-September 30, 1979. Final report, 5:24041 (LA—8323-PR)
Edgerton, J., Where Carter's energy program goes wrong, 5:24207
Edie, D.D., *See* Costello, V.A., 5:23977
Edighoffer, J.A., *See* Pantell, R.H., 5:25041
Edmonds, P.H., *See* Pearce, J.W., 5:25086
Edwards, D. Jr., Methane outgassing from a Ti sublimation pump, 5:24558
Self-modulating ion gauge, 5:24536
Edwards, J.J., *See* Giometti, C.S., 5:24673
Efimov, V.N., *See* Gryazed, V.M., 5:24079
See Gryazev, V.M., 5:24060
Egelhof, P., Vector analyzing power in the elastic scattering of ^{6}Li(pol) by ^{4}He, 5:24892
Eggers-Lura, A., *See* Fordsmand, M., 5:23883
Eichfeld, W.F., *See* Munson, D.E., 5:23538
Eichler, E., *See* Yates, S.W., 5:24922
Eimerl, D., Optical extraction characteristics of homogeneously broadened cw lasers with nonsaturating lasers, 5:24524
Einhorn, I.N., Physiological and toxicological aspects of degradation

products produced during the combustion of polyvinyl chloride polymers, 5:24451 (EPRI-EL—1263, pp 3.1-3.47)
Eisen, Y., *See* Stokstad, R.G., 5:24916
Eisenberg, M., Transition metal sulfide-lithium organic electrolyte rechargeable cells, 5:24165
Eisenberg, W., *See* Giori, C., 5:23450
El-Genk, M.S., Assessment of molten debris freezing in a severe RIA in-pile test, 5:24088 (CONF-800607—15)
El-Mitiny, R., *See* Majidzadeh, K., 5:23502
El-Sayed, M.A., *See* Terner, J., 5:24685
El-Shafee, O., Analytical method for determining seismic response of cooling towers on footing foundations. Interim report no. 1, 5:24009 (PB—301308)
El-Sheikh, K.A., Metholology for the selection of LWR safety R & D projects. Phase I, status report, 5:24082 (ALO—66)
El-Wakil, M.M., *See* Meyer, B.A., 5:23973
Eldridge, B.G., Solar production of industrial process steam for The Home Laundry, 5:23927 (SERI/TP—333-429, pp 257-261)
Solar production of industrial process steam (NL Industries, Inc. Project; Newberry Springs, California), 5:23931 (SERI/TP—333-429, pp 277-282)
Eldridge, O.C., *See* Gilgenbach, R.M., 5:24988
Elliott, J.H., *See* Campbell, G.W., 5:24573
Ellis, H.T., *See* Henderson, C., 5:24271
Ellison, W., By-product-utilization/ultimate-disposal of gas cleaning wastes from coal-fired power generation, 5:23477 (METC/SP—79/10(Pt.1), pp 328-343)
Ellman, M.J., Two-phase vapour-liquid flow with phase change, review, 5:24529 (PB—299905)
Ells, G.D., Michigan's Silurian oil and gas pools. Report of investigation 2, 5:23574
Ellyn, M., *See* Barnhouse, L., 5:24180
Elrod, S.H., Aqueous drilling fluid and lubricant composition, 5:23580
Emerson, L.C., *See* Clausing, R.E., 5:25094
See Langley, R.A., 5:25088
Emigh, R.A., *See* Alford, W.P., 5:24918
Enge, H.A., *See* DiRienzo, A.C., 5:24929
Engelbrecht, A.D., Operating experience on a 1,000-ton/day ammonia plant at Modderfontein, 5:23790
Engelke, M.J. Jr, The biology of salt wells creek and its tributaries, southwestern Wyoming. Water-resources investigations, 5:24659 (PB—300828)
Engelke, R., Effect of a chemical inhomogeneity on steady-state detonation velocity, 5:24585
England, A.C., *See* Gilgenbach, R.M., 5:24988
England, T.R., TMI-2 decay power: LASL fission-product and actinide decay power calculations for the President's commission on the accident at Three Mile Island, 5:24047 (LA—8041-MS(Rev))
Engstrom, H., Infrared reflectiity and transmissivity of boron implanted, laser annealed silicon, 5:24393 (CONF-791112—65)
Epler, J.L., *See* Rao, T.K., 5:24765
Epler, J.S., *See* Jacobs, D.G., 5:23733
Eppley, W.J., Lithium/thionyl chloride reserve cell development, 5:24120
See Shah, P.M., 5:24169
Epshtein, I.M., *See* Voloshina, E.A., 5:24747
Epstein, G.N., What can we learn about nuclear electric dipole moments from parity nonconservation in atomic transitions?, 5:24864
Erbacher, J.K., Low temperature, long-life, pelletized LiAl/$CuCl_2$ single cell for thermal battery applications, 5:24108
Ergun, S., Catalytic biomass liquefaction, 5:23836 (LBL—10667)
Erickson, L.M., *See* Vantine, H.C., 5:24296
Eriksson, S., Treatment of liquid effluents from coal gasification plants, 5:23515
Erisman, L.R., *See* Brown, R.A., 5:24137
See Higgins, R.L., 5:24144
Ershagi, I., *See* Doscher, T., 5:23577
Esbensen, T.V., Solar-assisted low energy dwellings, 5:23879 (DOE/CS—T0145)
Escher, W.J.D., *See* Donnelly, J.J. Jr., 5:24340, 5:24341
Estabrook, K.G., Heating by the Raman instability, 5:24983 (UCRL—84270)
Estrin, G., *See* Campos, I.M., 5:25102, 5:25103
Evans, E.G., *See* Fair, D.H., 5:24610
Evans, L.S., Plant developmental system to measure the impact of pollutants in rain water, 5:24768
Evans, M.L., NDA technology for uranium resource evaluation. Progress report, January 1-June 30, 1979, 5:23696 (LA—8321-PR)
Evans, R.M., *See* Waterland, L.R., 5:24547

F

Faber, J.H., Fifth international ash utilization symposium, 5:23460 (METC/SP—79/10(Pt.1))
Fifth international ash utilization symposium, 5:23482 (METC/SP—79/10(Pt.2))
Standard specification for fly ash and raw or calcined natural pozzolan for use as a mineral admixture in portland cement concrete, 5:23511 (METC/SP—79/10(Pt.2), pp 935-937)
Title 15, United States Code, Section 2300: consumer product warranties. The Magnuson-Moss Warranty Act, 5:24314 (METC/SP—79/10(Pt.2), pp 938-939)
Uniform Commercial Code (UCC), sections from Article 2: sales, 5:23512 (METC/SP—79/10(Pt.2), pp 940-950)
Faddick, R.R., *See* Link, J.M., 5:23644
Fahrenbruch, A.L., *See* Courreges, F.G., 5:23824
See Tsai, M., 5:24294
Fair, D.H., Air quality data for nonmetallic inorganic ions: NH4+, NO3-, SO4= from the National Air Surveillance Networks, 1976. Final report, 5:24610 (PB—300458)
Fairbanks, J.W., *See* Boone, D.H., 5:24293
Fajer, J., *See* Davis, M.S., 5:24680, 5:24681
Falk, A.Y., Partial liquefaction of coal by direct hydrogenation. Quarterly progress report, October-December 1979, 5:23445 (FE—2044-51)
Fan, L.T., *See* Akinc, M., 5:24311
Farnsworth, A.V. Jr., *See* Burns, E.J.T., 5:24481
Farrell, K., Experimental observations of effects of inert gas on cavity formation during irradiation, 5:24423 (ORNL/TM—7193)
See Lewis, M.B., 5:24359
Farrier, D.S., Environmental research for in situ oil shale processing, 5:23667
See Hepler, D.I., 5:23648
See Skinner, Q.D., 5:23664
See Williams, S.E., 5:23663
Farris, D.R., Adaptive control for energy conservation, 5:23884 (LA-UR—80-693)
Farrow, R.L., Raman spectroscopy of surface oxides at elevated temperatures, 5:24464
Farson, D.A., *See* Schwarz, R.I., 5:24708
Fattor, A.P., Concentrating solar heat collector, 5:23965
Faucett, H., *See* Faucett, K., 5:23872
Faucett, H.L., *See* Burnett, T.A., 5:24038
Faucett, K., Solar hot water preheater kit: problems, economics, performance, 5:23872
Faulkner, J.S., Calculating properties with the coherent-potential approximation, 5:24958
Fausett, D.W., *See* Lawlor, D.L., 5:23630
Fay, W.M., Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
Fazzolare, R., *See* Smith, S.E., 5:23916
Fedarko, W., Glass-fly ash from a new hot gas clean-up process, 5:23413 (METC/SP—79/10(Pt.1), pp 205-214)
Fedotovich, G.V., *See* Laptev, V.D., 5:24564
Feeney, R.K., *See* Hughes, D.W., 5:24820
Feibelman, P., *See* Levinson, H.J., 5:24409
Feibelman, P.J., Aims and recent accomplishments of surface theory, 5:24966
Feit, M.D., Computation of mode properties in optical fiber waveguides by a propagating beam method, 5:24973
Feld, M.S., *See* Pappas, P.G., 5:24813
Feldman, G.J., *See* Himel, T.M., 5:24840
Feldman, W.C., *See* Gosling, J.T., 5:24798
Feltham, C., *See* Birt, D., 5:24125
Fenili, R.N., *See* Delaney, J.B., 5:23600
Fenimore, E.E., Solar wind flows associated with hot heavy ions, 5:24796 (LA—8344-T)
Ferbel, T., *See* Berg, D., 5:24841
Ferguson, S.E., *See* Parker, J.C., 5:24657
Ferreira, A., *See* Coppi, B., 5:24986
Ferrell, P., *See* Vizcaino, H., 5:23675
Fertl, W.H., Method for monioring fluid movement behind casing in oil and gas wells, 5:23586
Fick, D., *See* Egelhof, P., 5:24892
Field, A.A., Solar energy in Europe, 5:23796
Fields, D.E., User's manual for DWNWND: an interactive Gaussian plume atmospheric transport model with eight dispersion parameter options, 5:24633 (ORNL/TM—6874)
Figueira, J.F., *See* Watkins, D.E., 5:24475
Figueroa, C., *See* Ergun, S., 5:23836
Fillo, J.P., Studies of phenolic compound decomposition under Synthane gasifier conditions. Final report, 5:23420 (FE—0208-T1)
Fincher, C.R. Jr., Temperature dependence of the phonon dispersion in Tl_3PSe_4, 5:24466
Fine, D.A., *See* Fletcher, A.N., 5:24109
Fine, T.L., Remarks on the assessment, representation, aggregation and utilization of expert opinion, 5:23749 (UCID—18665)
Fink, D.J., Carbohydrate crops as a renewable resource for fuels production. Volume III. Juice preservation, 5:23833 (BMI—2031(Vol.3))
Fink, R.W., *See* Gnade, B.E., 5:24815
Finlay, R.W., Isovector deformation parameters and core polarization, 5:24915
Finn, M.G., Educational and demographic characteristics of energy-related scientists and engineers, 1976, 5:24332 (DOE/IR/0033—T2)
Finn, P.A., *See* Pierce, R.D., 5:24232
Finney, B.C., *See* Tedder, D.W., 5:23715
Finson, M.L., Coal processing for fuel cell utilization. Task XI. Fluidized bed coal gasification model; data analysis

and predictions, 5:23428 (METC—8450-T1)
Fiore, V.B., Gas Research Institute's solar-augmented applications in industry program, 5:23913 (SERI/TP—333-429, pp 115-120)
Firment, L.E., Low energy electron diffraction (LEED) study of the adsorption of acetic acid and propanoic acid on Ag(111) and Pt(111), 5:24406
Firor, K., Overview of thick-film technology as applied to solar cells, 5:23821 (SERI/TP—331-541)
Fish, M.J., Utility views on solar thermal central receivers, 5:23858 (SAND—80-8203)
Fishman, H., *See* Suckewer, S., 5:24528
Fitzgerald, T.J., Measuring and modeling solids movement in a large, cold fluidized bed test facility. First quarterly report, 1 October, 31 December 1979, 5:23560 (DOE/ET/13152—1)
Fleck, J.A. Jr., *See* Feit, M.D., 5:24973
Fleet, C., Current issues in statewide transportation planning, 5:24282 (PB—301172)
Fleming, R.B., Development of bakeable seals for large noncircular ports on the Tokamak Fusion Test Reactor, 5:24534
Fletcher, A.N., New electrochemical cells based upon molten nitrate salts, 5:24109
Flint, B.K., Krypton fluoride laser mirror study. Final report, October 1978-November 1979, 5:24521 (DOE/DP/40001—1)
Florence, A.L., *See* Tobin, R.J., 5:24096
Florey, D., *See* Levy, A., 5:24256
Floyd, R.K., *See* Rose, J.G., 5:24035
Flynn, E.R., *See* Brown, R.E., 5:24917
Fodor, G.E., Fire-safe hydrocarbon fuels, 5:23599
Foerster, C., *See* Skelton, R., 5:24535
Fogleman, S.F., Conceptual design of retrieval systems for emplaced transuranic waste containers in a salt bed depository. Final report, 5:23750 (UCRL—15228)
Fonash, S.J., *See* Kar, S., 5:24539
Fong, D., *See* Brick, D., 5:24854
Fong, S., *See* Thompson, L.H., 5:24710
Fontana, J., *See* Zeldin, A., 5:24439, 5:24444
Fontanilla, J.E., *See* Meyer, R.A., 5:24913
Foote, J.H., *See* Grubb, D.P., 5:25006
Ford, C.T., Evaluation of the effects of coal cleaning on fugitive elements. Phase I. Final report, March 1, 1977-January 31, 1978, 5:23540 (FE—9145-1)
Ford, J.A., *See* Tippets, F.E., 5:24056
Ford, J.L.C. Jr., *See* Cordell, K.R., 5:24900
See Shapira, D., 5:24898
Ford, R.D., *See* Burton, J.K., 5:25056
Fordsmand, M., Feasibility study on a combined summer cooling and winter heating system, based on a combination of solar energy and ground heat pumps, 5:23883 (EUR—6701)
Forman, A., *See* Davis, M.S., 5:24680, 5:24681
Forman, S.E., *See* Hornig, C.F., 5:23805
Forslund, D.W., *See* Bezzerides, B., 5:24989
Forte, T.M., Changes in plasma lipoprotein distribution and formation of two unusual particles after heparin-induced lipolysis in hypertriglyceridemic subjects, 5:24718
Foskett, W.A., Balancing the objectives of clean air and economic growth: regulated markets in emission reductions. Interim report, 5:24639 (PB—300835)
Foss, M.H., *See* Arnold, R.C., 5:24551
Fostel, H., *See* Anderson, J.H., 5:24599
Fowler, G.G., Fly ash in paving and structural concrete, 5:23489 (METC/SP—79/10(Pt.2), pp 587-609)
Fowler, H., Solar-powered thermionic-photoelectric laser, 5:24231
Fowler, J.L., *See* Johnson, C.H., 5:24992
Fowler, T.K., Plasma confinement apparatus using solenoidal and mirror coils, 5:25046
Fox, R.A. J540, Site 32sn102, Stutsman County, North Dakota: a description and analysis. Final report August-December 1978, 5:24781 (PB—299924)
Franciosi, A., *See* Rosei, R., 5:24401
Franey, M.A., Sub-Coulomb transfer reactions on ^{208}Pb with carbon and oxygen projectiles, 5:24933
Frank, H.A., Triplet states in photosystem I of spinach chloroplasts and subchloroplast particles, 5:24678
Franke, F.H., High-temperature Winkler coal gasification process, 5:23433
Franklin, M.E.B., *See* Himel, T.M., 5:24840
Frantz, C.E., Device and method for shortening reactor process tubes, 5:24066
Fredberg, E.C., *See* Williams, J.I., 5:24741
Freeman, J.R., *See* Humphries, S. Jr., 5:24550
French, T.R., Precipitation of petroleum sulfonates by magnesium ions, 5:23578 (DOE/BETC/RI—80/3)
Frerking, C.E., *See* Koehler, H.A., 5:24995
Friedman, J., Advanced development of a short-residencemtime hydrogasifier. Quarterly technical progress report, October 1, 1979-December 31, 1979, 5:23427 (FE—3125-15)
Fristrom, R.M., Polymer combustion mechanisms, 5:24450 (EPRI-EL—1263, pp 2.1-2.27)
Fritsch, F.N., Improved monotone piecewise cubic interpolation algorithm, 5:25113 (UCID—18620)
Fryer, A.J., Evaluation of zinc/silver chloride batteries after 10 years storage, 5:24129
Fryer, R.M., *See* Gross, K.C., 5:24051
Fu, C., *See* Brick, D., 5:24854
Fu, Y.K., Modification by cysteamine of ultrasound lethality to Chinese hamster V-79 cells, 5:24779
Fujii, H., *See* Kasai, H., 5:23609
Fulk, M.M., *See* Hill, J.H., 5:23991
Fuller, D.W., Great Lakes: a valuable link in the intermodal movement of western coal, 5:23554
Furcinitti, P.S., *See* Griffin, G.D., 5:24762

G

Gabrielse, G., Measurement of the n = 2 density operator for hydrogen atoms produced by passing protons through thin carbon targets, 5:24810
Gadzhiev, G.I., *See* Gryazev, V.M., 5:24060
Gagnon, J.L., *See* Rammey-Smith, A., 5:24212
Gal, M., *See* Tserruya, I., 5:24907
Gaiser, J., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Gakis, J.D., *See* Mauro, P.G., 5:24040
Galehouse, D.C., Titanium oxide Phi system, 5:24816
Galligan, J.M., *See* Motowidlo, L., 5:24403
Galloway, T.R., Tritium management in fusion synfuel designs, 5:23765 (UCRL—83928)
Gamble, T.D., Magnetotellurics with a remote magnetic reference, 5:24788
See Goubau, W.M., 5:24790
Gammage, R.B., Ceramic BeO exoelectron dosimeters for tritium and radon monitoring, 5:24561 (CONF-7910149—1)
See Matthews, T.G., 5:24592
See Vo-Dinh, T., 5:24651
Gangadharan, A.C., *See* Allen, D.J., 5:23909
Garcia, A., Investigation of proposed process sequence for the array automated assembly task. Phase II. Quarterly technical progress report, March 28, 1980, 5:23811 (DOE/JPL/954853—80/9)
Gardner, L.D., Electron-capture collisions at keV energies of boron and other multiply charged ions with atoms and molecules. II. Atomic hydrogen, 5:24824
See Bayfield, J.E., 5:24826
Gardner, W.L., *See* Menon, M.M., 5:25063
Garland, J.J., Minimizing fire potential in power plant cable systems, 5:24074 (EPRI-EL—1263, pp 11.1-11.12)
Garpman, S.I.A., Thermodynamic behavior of non-strange baryonic matter, 5:24941
Garrison, B.J., *See* Holland, S.P., 5:24807
Gartner, E.M., Use of precalciners to remove alkali from raw material in the cement industry. Quarterly technical progress report, August-October 1979, 5:24291 (COO—4929-5)
Gary, J.H., Eleventh oil shale symposium proceedings, 5:23616
Twelfth oil shale symposium proceedings, 5:23615
Gaskill, J.R., Smoke and corrosivity, 5:24452 (EPRI-EL—1263, pp 4.1-4.15)
Gasper, J.R., *See* Habegger, L.J., 5:23847
Gasser, R.D., Containment response to postulated core meltdown accidents in the fast flux test facility, 5:24098
Gatacre, J., *See* Gunderson, J., 5:24352
Gateau, P., *See* Durand, J.P., 5:23596
Gaudy, A.F. Jr., *See* Kincannon, D.F., 5:24313
Gauger, W.K., *See* Williams, S.E., 5:23663
Gauthier, P., *See* Petrasso, R., 5:24999
Gaven, J.V. Jr., Chemical temperature indicators for geothermal applications. Final report, 5:23996 (DGE—4008-F)
Gay, T.J., Temperature dependence of the beam-foil interaction, 5:24811
Gazes, S.B., *See* DiRienzo, A.C., 5:24929
Gazzaly, M., *See* Adams, G.S., 5:24911
Geesaman, D.F., *See* Paul, M., 5:24904
See Prosser, F.W. Jr., 5:24906
See Sanders, S.J., 5:24905
Gelb, G.H., *See* DeLuca, W.H., 5:24154
Gelbke, C.K., *See* Egelhof, P., 5:24892
Geldart, D.J.W., *See* Rasolt, M., 5:24967
George, M.A., *See* Leyerle, R.W., 5:24241
George, S.M., *See* Harris, C.B., 5:24476
Gerassimenko, M., *See* Petrasso, R., 5:24999
Gerwin, R., Ohmic heating of the reversed-field pinch, 5:24979 (LA—8325-MS)
Gharib, S., *See* Doscher, T., 5:23577
Ghosh, A.K., *See* Strongin, M., 5:24367
Gibson, E.D., Low/medium Btu gasification: a summary of applicable EPA regulations, 5:23531
Gidal, G., *See* Himel, T.M., 5:24840
Giese, R., *See* Asbury, J., 5:24243
Giesler, G.C., *See* Orth, C.J., 5:24914
Gilat, J., Levels of ^{230}Ac and ^{230}Th populated by decay of ^{230}Ra and ^{230}Ac, 5:24935
Giles, G.E. Jr., *See* Kirkpatrick, J.R., 5:24368
Giles, W.B., Laminar flow cyclone development program. Quarterly technical progress report, July 1, 1979-September 30, 1979, 5:24034 (FE—3242-11)

Gilgenbach, R.M., Heating at the electron cyclotron frequency in the ISX-B tokamak, 5:24988
Gill, J.T., Effect of container preparation on the growth of protium and methane impurities into tritium gas, 5:25095
Gillespie, T.J., Evaluation of ultrasonic cleaning systems, 5:24505 (GEPP-OP—501)
Gilliam, D.M., *See* Wagschal, J.J., 5:24070
Gilliland, M., *See* White, I.L., 5:23668
Gilmore, J.M., Buildup studies for MFTF-B, 5:24981 (UCID—18334)
Ginley, D.S., *See* Butler, M.A., 5:24500
See Seager, C.H., 5:23822
Ginocchio, J.N., *See* Orth, C.J., 5:24914
Giometti, C.S., Analytical techniques for cell fractions. XXVII. Use of heart proteins as reference standards in two-dimensional electrophoresis, 5:24673
Muscle protein analysis. I. High-resolution two-dimensional electrophoresis of skeletal muscle proteins for analysis of small biopsy samples, 5:24676
See Willard, K.E., 5:24674
Giori, C., Synthesis of thermosetting polymers from the by-products of coal conversion processes, 5:23450
Gitomer, S.J., *See* Bezzerides, B., 5:24989
Gladney, E.S., Observations on boron release from coal-fired power plants, 5:23532
Glasl, F.G., Performance improvement for ocean thermal energy conversion systems. Final report, 5:23869 (DSE—0034-T1)
Glendenning, N.K., *See* Garpman, S.I.A., 5:24941
Glodis, P.F., *See* Smith, D.E.A., 5:24853
Gnade, B.E., L/sub 2,3/-subshell x-ray fluorescence and Coster-Kronig yields at Z=64 and 67, 5:24815
Gneiting, B.C., *See* Bard, F.E., 5:24093
Godden, D., *See* Lurman, F., 5:24611
See Lurmann, F., 5:24612
Godfrey, G., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Goebel, F., *See* Marincic, N., 5:24150
Goeddel, D.L., Analysis of life-cycle costs and market applications of flywheel energy-storage transit vehicles. Final report 1977-78, 5:24344 (PB—300289)
Goettle, R.J. IV, *See* Groncki, P.J., 5:24201
Goff, F., In-progress geologic map of Canon de San Diego, Jemez Springs, New Mexico, and lithologic log of Jemez Springs geothermal well, 5:23984 (LA—8276-MAP)
Goff, F.E., Geothermal investigation of spring and well waters of the Los Alamos Region, New Mexico, 5:23986 (LA—8326-MS)
Gohar, A., *See* Paskin, A., 5:24964
Goland, A.N., *See* Klaffky, R.W., 5:24438
Gold, S.H., Laser scattering measurements of plasma turbulence in a fast theta pinch, 5:25009
See Ripin, B.H., 5:25074, 5:25082
Goldberg, D.A., *See* Zisman, M.S., 5:24903
Goldberg, E.D., Strategies for marine pollution monitoring, 5:24653
Golden, D., *See* Lihach, N., 5:24029, 5:24030
Goldfarb, A., *See* Barrett, K., 5:24638
Goldhaber, G., *See* Himel, T.M., 5:24840
Goldman, P., *See* Motowidlo, L., 5:24403
Goldsmith, W.A., *See* Berven, B.A., 5:23756
Goldstein, S.A., *See* Burns, E.J.T., 5:24481
See Ottinger, P.F., 5:25081
Golecki, I., *See* Masuyama, A., 5:24479
Gomez del Campo, J., *See* Shapira, D., 5:24898
Good, R.R., *See* Solbrig, C.W., 5:24081
Goodfellow, L., *See* Atwood, M.T., 5:23650
Goodman, A.C., Geothermal Energy Market Study on the Atlantic Coastal Plain. Geothermal Energy Market penetration: development of a model for the residential sector, 5:23998 (DOE/ET/27025—T1)
Goodman, A.L., Angular momentum fluctuation energy in the cranking model, 5:24949
Goodman, C.D., Excitation of giant resonances via charge exchange reactions, 5:24901 (CONF-7910148—1)
Goodman, F. Jr., *See* Nesbit, W., 5:24002
Goodman, G., *See* McDonald, G.D., 5:23817
Goranson, C.B., *See* Benson, S.M., 5:23999
Gordelier, S.C., Literature review of palliatives for fretting fatigue, 5:24418
Gordon, B.E., Critical examination of some newly available standards for liquid scintillation counting, 5:24720
Gordon, B.M., Use of a synchrotron radiation x-ray microprobe for elemental analysis at the National Synchrotron Light Source, 5:24487 (BNL—27611)
Gordon, D.M., International safeguards at the feed and withdrawal area of a gas centrifuge uranium enrichment plant, 5:23758 (BNL—27663)
Gosling, J.T., Solar wind ions accelerated to 40 keV by shock wave disturbances, 5:24798
Gosselin, L.J., Use of x-ray fluorescence spectral analysis in material characterization for quality control, 5:24531 (EPRI-EL—1263, pp 6.1-6.10)
Gottschalk, T., Process dependence of perturbative quantum-chromodynamic jet structures, 5:24884
Goubau, W.M., Magnetotelluric data analysis: removal of bias, 5:24790
See Gamble, T.D., 5:24788
Gould, P.L., *See* El-Shafee, O., 5:24009
Goyal, S.K., *See* Snow, R.H., 5:23632
Grady, D.E., Criteria for impulsive rock fracture, 5:24792
Granatstein, V.L., *See* Gilgenbach, R.M., 5:24988
Granchi, M.P., *See* Angevine, P.J., 5:23439
Granetz, R., *See* Petrasso, R., 5:24999
Grannan, D.M., *See* Morse, W.M., 5:24847
Grau, B., Compartmentalization of ^{14}C-DDT in an experimental old-field plot, 5:24644
Graves, G.P., Ash liability in cement replacement, 5:23488 (METC/SP—79/10(Pt.2), pp 579-586)
Gray, B., *See* Stabley, J.D., 5:25055
Greatbatch, W., *See* Holmes, C.F., 5:24148
Greayer, W.C., *See* Donnelly, J.J. Jr., 5:24340, 5:24341
Greben, J.M., Description of direct nuclear rearrangement reactions using various coupled channel equations, 5:24946
Greco, J., *See* Kanabrocki, E.L., 5:24484
Green, D.R., *See* Bionta, R.M., 5:24852
Green, L.A., *See* Angevine, P.J., 5:23439
Greenberg, R., *See* Springmann, H., 5:24222
Greene, C.H., Manifestation of dynamically unfavored transitions in the angular distribution of photofragments, 5:24831
Greene, D.L., Urban subcenters: recent trends in urban spatial structure, 5:24183
Greene, R.W., Economics of barge transport of coal, 5:23552
Greening, P.A.K., Modelling the demand for long-distance day trips to the lake district, 5:24289 (PB—300617)
Greenly, J., *See* Humphries, S. Jr., 5:24550
Greyerbiehl, J.M., New DOE-funded projects, 5:23908 (SERI/TP—333-429, pp 61-68)
Griffin, G.D., Reproductive survival and macromolecular synthesis in cultured mammalian cells exposed to single metabolites and mixtures of metabolites of benzo(a)pyrene, 5:24762 (CONF-791059—6)
Griffiths, T.D., *See* Fu, Y.K., 5:24779
Griggs, K.E., *See* Johnson, I., 5:23558
Grilly, J.M., *See* Begay, F., 5:24579
Grimes, J.G., *See* Butz, T.R., 5:23690
Grimm, R.C., *See* Dewar, R.L., 5:25026
Grimmett, E.S., Role of seed particles in the prediction and control of product particle size in fluidized-bed dryers, 5:23719 (ENICO—1036)
Grisaru, M.T., Reggeization of elementary fermions in arbitrary renormalizable gauge theories, 5:24858
Groebner, R.J., Vacuum ultraviolet spectroscopic study of plasma impurities in the Tokapole II poloidal, 5:25001
Grogan, P., Emissions and effluent control costs of the US pulp and paper industry, 5:24588 (ANL/EES-TM—83)
Groncki, P.J., Economic assessment of alternative energy policies, 5:24201 (BNL—27721)
Grosjean, D., *See* Pitts, J.N. Jr, 5:24620
Gross, K.C., Development of a methodology for analysis of delayed-neutron signals, 5:24051 (ANL—79-57)
Grossman, R.F., *See* Potter, G.D., 5:24630
Grow, B., *See* Gaven, J.V. Jr., 5:23996
Grubb, D.P., Initial results of the Tandem Mirror Experiment (TMX) at the Lawrence Livermore Laboratory, 5:25006 (UCRL—84221)
Grun, J., *See* Ripin, B.H., 5:25082
Grunhaus, J., *See* Brick, D., 5:24854
Grunnet, M.L., *See* Einhorn, I.N., 5:24451
Grutt, E.W. Jr., Department of Energy's Uranium Resource Assessment activities, 5:23674
Gryazed, V.M., Ensuring safe operation of the BOR-60 experimental fast reactor as an atomic power plant, 5:24079 (PNL-TR—397)
Gryazev, V.M., Study of the operational characteristics of the core and irradiated fuel parameters in the BOR-60 reactor, 5:24060 (PNL-TR—398)
Gudrais, P.G., *See* Abraham, K.M., 5:24153
Gugelot, P.C., *See* Kaelline, J., 5:24889
Guichard, J., *See* Breton-Gorius, J., 5:24729
Guidry, M.W., *See* Yates, S.W., 5:24922
Guillet, R., Pituitary-adrenal response in neonatal rats, 5:24716
Guilmette, R.A., *See* Cohen, N., 5:24758
Gulkok, Y.Z., *See* Bayfield, J.E., 5:24826
Gulledge, W.P., *See* Webster, W.C., 5:23483
Gullicks, H.A., *See* Manz, O.E., 5:23505
Gully, J.H., Rebuilding the five megajoule homopolar machine at the university of texas, 5:25057
See Bullion, T.M., 5:25059
Gunderson, J., Motor vehicle emissions inspection/maintenance program for South Carolina. Final report, 5:24352 (PB—300304)
Gunderson, T.C., *See* Romero, R., 5:23729
Guntrum, S.K., *See* Stowers, I.F., 5:24517
Gupta, G.D., Solar production of industrial process steam at Dow Chemical Company's Dalton, Georgia, Latex Manufacturing Plant, 5:23930 (SERI/TP—333-429, pp 273-275)
See Allen, D.J., 5:23909
Gurtler, R.W., Optically driven solar engine, 5:23857
Gurtowski, L., *See* Horie, Y., 5:24613
Gurvitch, M., Resistivity anomaly in thin Bi wires: Possibility of a one-dimensional quantum size effect, 5:24405

Gustafson, P.S., *See* Kanabrocki, E.L., 5:24484
Gustavson, T.C., Environmental overview of geopressured-geothermal development: Texas Gulf Coast, 5:23995 (UCRL—15094)
Guth, A.H., Phase transitions and magnetic monopole production in the very early universe, 5:24800
Guziel, K.A., Programmer's guide to the Argonne Coal Market Model, 5:23564 (ANL/EES-TM—84)

H

Haas, B., Single particle nature of the yrast line at high angular momentum in ^{152}Dy, 5:24923
Habegger, L.J., Health and safety. Preliminary comparative assessment of the satellite power system (SPS) and other energy alternatives, 5:23847 (DOE/ER—0053)
Haberle, J., *See* Foskett, W.A., 5:24639
Hackett, K.E., *See* Gilgenbach, R.M., 5:24988
Haddock, R.P., *See* Smith, D.E.A., 5:24853
Hadley, H.C. Jr, *See* Rothwarf, A., 5:23819
Haeusser, O., *See* Haas, B., 5:24923
Hafen, A.S., *See* Brick, D., 5:24854
Hage, G., *See* Howard, N.W., 5:24782
Hagler, M.O., *See* Druce, R.L., 5:25037
Hagmann, S., *See* Liesen, D., 5:24827
Hagopian, S., *See* Bugg, W.M., 5:24855
Hagopian, V., *See* Bugg, W.M., 5:24855
Haik, N., *See* Highland, V.L., 5:24843
Haimson, B.C., Effect of principal stress magnitudes on hydrofracturing orientation, 5:24791 (UCRL—15234)
Haire, R.G., *See* Roof, R.B., 5:24377
Halbreich, A., *See* Jakovcic, S., 5:24684
Hale, V.Q., *See* Lemmon, A.W. Jr, 5:23526, 5:23527
See Tolle, D.A., 5:23528
Halfon, L., Therapeutic adornments utilizing solar cells, 5:23854
Hall, B.R., Solar augmented soybean drying, 5:23923 (SERI/TP—333-429, pp 231-237)
Hall, D.C., *See* Barthelemy, R.R., 5:24247
Hall, E.J., *See* Miller, R.C., 5:24740
Hall, J.C., Design and testing of a large-scale lithium-silicon/FeS load-leveling cell, 5:24104
Hamasaki, S., Persistence of magnetohydrodynamic stability in field reversed pinches against microinstability, 5:25028
Hameiri, E., Local sufficient condition for magnetohydrodynamic stability of closed line systems, 5:25027
Hamilton, J.H., *See* Peker, L.K., 5:24919
See Yates, S.W., 5:24922
Hamilton, W., *See* Petrasso, R., 5:24999
Hammelman, J.E., Reliability analysis of the Georgetown University Atmospheric Fluidized Bed Combustor. Final report, 5:24543 (SAI—129-79-PGH)
Hammett, J.R., *See* Silflow, C.D., 5:24699
Han, J.T., Heat-transfer in a partially-blocked sodium-cooled rod bundle, 5:24053 (CONF-791205—23)
Handa, A.K., Assay of adenosine 3',5' cyclic monophosphate by stimulation of protein kinase: a method not involving radioactivity, 5:24672
Handler, T., *See* Brick, D., 5:24854
See Bugg, W.M., 5:24855
Hanna, W.W., Genetics of mutagen induced non-lethal chlorophyll mutants in pearl millet, 5:24715
Hannifan, M., *See* Place, W., 5:23886
Hansen, P., Government procurement of recycled products: fly ash in cement and concrete, 5:23464 (METC/SP—79/10(Pt.1), pp 51-55)
Hanson, D.L., *See* Cindro, N., 5:24909
Hanson, G., *See* Himel, T.M., 5:24840
Hanson, K., *See* Mahin, K.W., 5:24376
Hanson, W.C., Anaktuvuk Pass, Alaska village census, 5:24668 (PNL—3081)
Hanway, J.E., *See* Johnson, I., 5:23558
Hara, M., *See* Ikeda, H., 5:24145
Harak, A.E., *See* Young, C., 5:23638
Hardy, J., *See* Chauvin, G., 5:24105
Hargreaves, W.R., *See* Tyler, J.M., 5:24704
Harkness, J.D., Performance of nickel-cadmium satellite cells having new electrochemically impregnated, sintered electrodes, 5:24134
Harlow, R.A., *See* Topouzian, A., 5:24160
Harrington, W., Effectiveness and cost of air pollution control for coal-fired electric power plants in the west, 5:24037 (PB—300515)
Harris, C.B., Critical test of vibrational dephasing theories in liquids by use of selective, coherent, picosecond Stokes scattering, 5:24476
Harris, D.P., Probabilistic endowment appraisal system based upon the formalization of geologic decisions. General description, 5:23673 (GJBX—112(80))
Harris, E., *See* Thoem, T., 5:23669
Harris, E.F., *See* Thoem, T.L., 5:23670
Harris, H.E., Development of an area sampling methodology. Open file report (final) June 73-October 1975, 5:23523 (PB—299926)
Harris, J.S. Jr., *See* Zehr, S.W., 5:23818
Harris, W.F., *See* Klopatek, J.M., 5:24643
Hart, E., *See* Brick, D., 5:24854
Hart, E.L., *See* Bugg, W.M., 5:24855
Hartgen, D.T., *See* Zabinski, R.J., 5:24640
Hartman, C.W., Production of field-reversed mirror plasma with a coaxial plasma gun, 5:24976
Hartman, W.F., Acoustic monitoring of relief valve position, 5:24043 (EPRI-NP—1313)
Harwell, M.A., *See* Brandstetter, A., 5:23737
Hasegawa, A., Kinetic properties of Alfven waves, 5:25035
Haselton, H.H., *See* Kim, J., 5:24987
See Menon, M.M., 5:25063
Hass, B.S., Photodynamic effects of dyes on bacteria. I. Mutagenesis by acridine orange in the dark in excision- and recombination-deficient strains of Escherichia coli, 5:24766
Hassam, A.B.S., Characteristics and lifetime of convective plasma motions in tokamaks, 5:25034
Hassman, G.V., *See* Cox, L.E., 5:24348
Hatle, C., *See* Bissell, M.J., 5:24714
Haubenreich, P.N., Progress on large superconducting toroidal field coils, 5:25047 (CONF-791102—164)
Hauge, P.S., Conventions and formulas for using the Mueller-Stokes calculus in ellipsometry, 5:24971 (LBL—10172)
Haugen, D.A., Aryl hydrocarbon hydroxylase: degradation of product due to contaminant in acetone, 5:24671
Hawk, T., *See* Kraft, D.C., 5:23496
Hawkins, J.E., *See* Utter, S., 5:23623
Hawkins, J.R., *See* Lesieur, R.R., 5:23610
Haws, L.D., *See* Wang, P.S., 5:24437
Hawthorne, A.R., *See* Matthews, T.G., 5:24592
Hayes, K.G., *See* Himel, T.M., 5:24840
Haynes, R., Mining reclamation laws, 5:23571
Haywood, F.F., *See* Berven, B.A., 5:23756
Hazen, W., Uranium milling, 5:23701
Hazzard, G., *See* Birt, D., 5:24125
Head, W.J., Design and construction of experimental haul road and parking lot facilities utilizing power plant ash, 5:23495 (METC/SP—79/10(Pt.2), pp 679-693)
Heady, E.O., *See* Madsen, H.C., 5:24649
Heasley, S.D., *See* Bennett, M.E., 5:23603
Heatherly, D.E., *See* Vallet, C.E., 5:24122
Heatherly, L., *See* Clausing, R.E., 5:25094
Heck, R.H., *See* Angevine, P.J., 5:23439
Heck, R.M., *See* Olson, B.A., 5:24338
Hedetniemi, S.M., Which grids are Hamiltonian?, 5:25112 (SAND—80-0438C)
Hedetniemi, S.T., *See* Hedetniemi, S.M., 5:25112
Hedges, R.B., *See* Van Voast, W.A., 5:23530
Heffelfinger, J.M., *See* Hansen, P., 5:23464
Heft, R.C., Hybrid vehicle potential assessment. Volume 10. Electric and hybrid vehicle cost handbook, 5:24342 (CONS—4209-T1(Vol.10))
Heidbrier, W.G., Experience with solar heating, 5:23942
Heinemann, R.F., Multiplicity and stability of nonadiabatic hydrogen-oxygen-nitrogen flames, 5:23770
Heins, C., Scattergood School solar heating system, 5:23898
Heisenberg, J., *See* Lichtenstadt, J., 5:24931
Heistand, R.N., Product yields, 5:23624
See Jones, J.B. Jr., 5:23642
Heisterberg, R.H., Measurement of the cross section for ν/sub μ/$+e^- \rightarrow \nu$/sub μ/$+e^-$, 5:24848
Heitz, A., *See* Wahlig, M., 5:23887
Helgerson, R.N., *See* Butz, T.R., 5:23690
Heller, M., *See* Brick, D., 5:24854
Heller, S.C., *See* Heft, R.C., 5:24342
Helm, R.W., *See* Ahn, Y.K., 5:23835
Hendel, C.L., *See* Lowndes, D.H., 5:24402
Hendel, R., *See* Lowndes, D.H., 5:24402
Henderson, C., Energy study of automated guideway transit (AGT) systems, 5:24271 (SAN—1176-T3)
Henderson, R.P., Preliminary inductive energy transfer experiments, 5:25060
Hendler, F., *See* Jakovcic, S., 5:24684
Hendricks, C.D., Method and apparatus for producing small hollow spheres, 5:23763
See Weinstein, B.W., 5:23760
Hendry, D.G., Atmospheric reaction products of organic compounds. Final report, 5:24623 (PB—301384)
Henins, I., *See* Jarboe, T.R., 5:25049
Henkel, H.J., *See* Kuesebauch, W., 5:23771
Henning, W., *See* Paul, M., 5:24904
See Prosser, F.W. Jr., 5:24906
See Sanders, S.J., 5:24905
Henry, R.F., *See* Johnson, I., 5:23558
Henry, W.M., *See* Howes, J.E. Jr, 5:24608
Hepler, D.I., Toxicological evaluation of an in situ oil shale process water, 5:23648
Heppelmann, S., *See* Berg, D., 5:24841
Herbel, C.H., *See* Smith, G.S., 5:24331
Hereford, K., *See* Schultz, H.L., 5:24617
Herman, I.P., Molecular hydrogen exchange: A study of $HD(v=5)+HD(v=0) \rightarrow H_2+D_2$, 5:24496
See Marling, J.B., 5:24497
Hershcovitch, A., Method of evaluating the effects of particle scattering by fluctuations, 5:25039
Hertzmark, D., Agricultural sector impacts of making ethanol from grain, 5:23776 (SERI/TR—352-554)
Herz, J., *See* Trice, J.B., 5:23920
Hess, H., *See* Olson, B.A., 5:24338
Hess, P., Vibration→vibration energy transfer in methane, 5:24822
Hettena, R., Economics of oceanborne coal transportation, 5:23546
Hibbel, J., *See* Cornils, B., 5:23437
Hichwa, R.D., *See* Yates, S.W., 5:24922
Hickey, H.R. Jr, *See* Babb, M.C., 5:24185
Hickman, R.B., *See* Hoover, W.G., 5:24833

Hicks, B.B., Investigations of sparging as a method for promoting cooling pond heat transfer, 5:24530
See Sheih, C.M., 5:24627
Hiebert, R.D., *See* Bartholdi, M., 5:24576
Higginbotham, E.G., *See* Waterland, L.R., 5:24547
Higgins, R.I., Applications of the lithium/carbon mono-fluoride battery, 5:24144
Highland, V.L., New upper limit for the C-noninvariant decay $\pi^0 \rightarrow 3\gamma$, 5:24843
Higuera, M.L., *See* Howard, N.W., 5:24782
Hilfman, L., Hydroprocessing of hydrocarbons over nickel, moly, platinum catalyst, 5:23593
Hill, F.E., Performance characteristics of iron nickel batteries, 5:24136
Hill, J.E., *See* Jones, D.E., 5:23890
Hill, J.H., Improvements in geothermal electric power and silica production, 5:23991
See Stephens, F.B., 5:23993
Hill, N.W., *See* Johnson, C.H., 5:24992
Hill, R.A., Effect of satellite Q-branches on temperatures computed from oxygen vibrational Raman intensities, 5:24817
Hilscher, D., *See* Wilcke, W.W., 5:24937
Himel, T.M., Measurement of $\gamma\gamma$psi final states in psi' decay, 5:24840
Himey, A., Substitutes for mercury in alkaline zinc batteries (II), 5:24167
Hind, G., *See* Crowther, D., 5:24686
Hine, G.J., Measurements of the performance parameters of gamma cameras: Part II. Final report, 5:24562 (PB—301041)
Hinshelwood, D.D., *See* Pappas, P.G., 5:24813
Hinton, F.L., *See* Wiley, J.C., 5:25020
Hitlin, D.G., *See* Himel, T.M., 5:24840
Ho, F.F., *See* Yoo, H.I., 5:23813
Hobart, W., Marine fisheries review, volume 41, number 3, March 1979, 5:24656 (PB—300280)
Hodby, J.W., Excitation by light pulses of mechanical vibrations in solids, 5:24468
Hodges, L., Passive design tutorial, 5:23899
See Block, D.A., 5:23903
Hodson, E.K., *See* Virchow, C.F., 5:24586
Hodson, S.W., *See* Cox, A.N., 5:24795
Hoecker, K.H., Energy-industry-environment system of Baden-Wuerttemberg, 5:24176 (IKE-K—54-19)
Hoeistad, B., *See* Kaellne, J., 5:24889
Hoffman, D.C., *See* Wilhelmy, J.B., 5:24938
Hoffman, J.A., Wind energy system time-domain (WEST) analyzers using hybrid simulation techniques, 5:24004 (DOE/NASA/0026—79/1)
Hoffmann, G.W., *See* Adams, G.S., 5:24911
Hofstadter, R., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Hogan, S., *See* Firor, K., 5:23821
Hoida, H.W., *See* Jarboe, T.R., 5:25049
Holcombe, H.T., *See* Jiracek, G.R., 5:24789
Holian, B.L., *See* Hoover, W.G., 5:24833
Holland, S.P., Azimuthal anisotropies of dimer ions ejected from ion bombarded Ni(001), 5:24807
Hollebeek, R.J., *See* Himel, T.M., 5:24840
Holleck, G.L., Improvement and cycle testing of Ni/H_2 cells, 5:24135
See Abraham, K.M., 5:24153
Holley, J.A., *See* Darby, L.B., 5:23582
Hollowell, C.D., Impact of reduced infiltration and ventilation on indoor air quality, 5:24624
Holmes, C.D., Coal and its future, 5:23565 (METC/SP—79/10(Pt.1), pp 39-44)
Holmes, C.F., Use of microcalorimetry in characterization of lithium pacemaker batteries, 5:24148
Holmes, W.S., *See* Holmes, C.F., 5:24148
Holt, D.M., *See* Virchow, C.F., 5:24586
Holt, J.G., Absorbed dose measurements using parallel plate polystyrene ionization chambers in polystyrene phantoms, 5:24954
Holt, R.J., Photoneutron studies of E1, M1, and E2 excitations in ^{13}C, 5:24897
Holtzman, S., Synergism of diethylstilbestrol and radiation in mammary carcinogenesis in female F344 rats, 5:24749
Homma, M., *See* Okada, M., 5:24373
Hong, H.Y.P., High Na^+-ion conductivity in $Na_5YSi_4O_{12}$, 5:24435
See Kafalas, J.A., 5:24158
Hong, M., Development of A-15 (V_3Ga) superconducting material through controlled precipitation, 5:24515
Hood, D.W., *See* Smartt, H.B., 5:24290
Hoover, W.G., Bulk viscosity via nonequilibrium and equilibrium molecular dynamics, 5:24833
Hopkins, J.B., Vibrational relaxation in jet-cooled alkyl benzenes. II. Fluorescence spectra, 5:24812
Hopkins, R.H., Silicon materials task of the low cost solar array project (Phase III). Effect of impurities and processing on silicon solar cells. Phase III summary and seventeenth quarterly report, Volume 1: characterization methods for impurities in silicon and impurity effects data base, 5:23809 (DOE/JPL/954331—80/9)
Silicon materials task of the low cost solar array project (Phase III). Effects of impurities and processing on silicon solar cells. Phase III summary and seventeenth quarterly report, Volume 2: analysis of impurity behavior, 5:23810 (DOE/JPL/954331—80/9(Vol.2))
Hopper, J.L., *See* Potter, G.D., 5:24630
Horie, Y., Weekend/weekday differences in oxidants and their precursors. Final report, 5:24613 (PB—300479)
Horn, D., *See* Haas, B., 5:24923
See Kubono, S., 5:24908
Horne, A.J., Nitrogen fixation in Clear Lake, California. 4. Diel studies on Aphanizomenon and Anabaena blooms, 5:24689
Hornig, C.F., Solar photovoltaic module degradation from electro-migration, 5:23805 (COO—4094-64)
Horning, R.J., *See* Eppley, W.J., 5:24120
Hornstra, F. Jr., *See* DeLuca, W.H., 5:24154
Horton, R., *See* Wong, K.L., 5:25003
Horvath, D.J., *See* Keefer, R.F., 5:23517
Hoskins, W.N., *See* Crookston, R.B., 5:23652
Howard, D., *See* Miller, M.E., 5:24690
Howard, N.W., LLL continental drilling for scientific purposes data base: DOE-funded drill holes, 5:24782 (UCRL—52909)
Howard, P.A., *See* Carbajo, J.J., 5:24062
Howard, W.M., *See* Cusson, R.Y., 5:24927
Howe, H.C., Hydrogen recycle modeling in transport codes, 5:25010 (CONF-791057—4)
See Gilgenbach, R.M., 5:24988
Howerton, R.D., Annual environmental monitoring report, January-December 1979, 5:24646 (RFP-ENV—79)
Howes, B.W., *See* Brandstetter, A., 5:23737
Howes, J.E. Jr, Evaluation of stationary source particulate measurement methods. Volume V. Secondary lead smelters. Interim report oct 73-June 1977, 5:24608 (PB—300337)
Hoyles, M.R., *See* Zabinski, R.J., 5:24640
Hsiao, C.K., *See* Loutfy, R.O., 5:23827
Hsie, A.W., Screening for mutagenic response of six coded chemicals in the CHO/HGPRT system, 5:24763 (CONF-7910146—1)
Hsieh, B.J., Use of endochronic plasticity for multi-dimensional small and large strain problems, 5:24385 (ANL-CT—79-19)
Hsieh, C.L., *See* Terner, J., 5:24685
Hsieh, E.J., *See* Burt, R.J., 5:24809
Hsu, M.S., *See* Hornig, C.F., 5:23805
Huber, E.E., *See* Burgess, R.L., 5:24642
Hudson, E.A., *See* Groncki, P.J., 5:24201
Hudson, J.B., *See* Mohnen, V.A., 5:24619
Huebener, R.P., *See* Clem, J.R., 5:24514
Huey, S., *See* Bennett, M.E., 5:23603
Huffsmith, S.A., *See* Landingham, R.L., 5:24427
Huggett, C., Measurement and meaning of flame retardancy, 5:24442 (EPRI-EL—1263, pp 8.1-8.8)
Hughes, D.W., Absolute experimental cross sections for the electron impact ionization of rubidium. Technical summary report, 5:24820 (ORO—3027-52)
Hui, B., *See* Gilgenbach, R.M., 5:24988
See Ott, E., 5:24984
Huizenga, J.R., *See* Wilcke, W.W., 5:24937
Hulman, P., Development of questionnaires for various emission inventory uses. Final report, 5:24587 (PB—300384)
Hulsizer, R.I., *See* Brick, D., 5:24854
Hummel, M.F., Quest for certified slar energy engineering personnel, 5:23801
Humphrey, H.J., *See* Lechnick, W., 5:23473
Humphrey, J.P., Extraction of hydrocarbons from Antrim oil shale, 5:23636
See Peil, C.A., 5:23622
Humphries, S. Jr., Intense pulsed ion beams for fusion applications, 5:25075 (SAND—80-0402)
Longitudinal instabilities of pulseline driven neutralized linear ion accelerators, 5:24548
Production and postacceleration of intense ion beams in magnetically insulated gaps, 5:24550
Hundemann, A.S., Energy policy and research planning. Volume 3. October, 1977-September, 1979 (a bibliography with abstracts). Report for October 1977-September 1979, 5:24205 (NTIS/PS—79/1069)
Hunsicker, P.R., *See* Russel, W.L., 5:24774
Hunter, T.O., Role of borehole plugging in the evaluation of the Waste Isolation Pilot Plant, 5:23744 (SAND—80-0502C)
Huray, P.G., *See* Nave, S.E., 5:24578
Hurlbut, B.J., *See* Blue, J.L., 5:24244
Hurst, V.J., Fly ash for use in the industrial extender market, 5:23468 (METC/SP—79/10(Pt.1), pp 90-133)
Hussey, C.L., *See* Erbacher, J.K., 5:24108
Hutchins, J.C., *See* Robins, J.D., 5:23525
Hutchinson, D.L., Investigation of the Geokinetics horizontal in situ oil shale retorting process. Quarterly report, January-March 1980, 5:23625 (DOE/LETC/10787—44)
Hutchinson, D.P., *See* Vander Sluis, K.L., 5:24993
Huth, G.C., *See* Akutagawa,W.M., 5:24721
Hwang, H.H., Study of the feasibility of linking the islands of Maui, Molokai, and Lanai with submarine electrical power cables, 5:24039 (HNEI—7902)
Hyland, E.J., Responsibility for quality control and quality assurance of fly ash, 5:23462 (METC/SP—79/10(Pt.1), pp 34-38)
Hylton, J.O., *See* Eads, B.G., 5:24085

I

Igo, G., *See* Adams, G.S., 5:24911
Ihm, J., Comment on "Correction to Fuchs' calculation of the electrostatic energy of a Wigner solid", 5:24963
Ikeda, H., Lithium-manganese dioxide cell, 5:24145
Ilan, Y., Iron hexacyanide/cytochrome-C - intramolecular electron transfer and binding constants - (pulse radiolytic study). Progress report, 5:24504 (DOE/EV/03221—66)
See Ilan, Y.A., 5:24733
Ilan, Y.A., Chain inequivalence in bovine methemoglobin. Progress report, December 1, 1979-November 30, 1980, 5:24733 (DOE/EV/03221—61)
See Chevion, M., 5:24670, 5:24735
Iles, P.A., *See* Yoo, H.I., 5:23813
Imamura, M.S., *See* Lear, J.W., 5:24139
Impellezzeri, J.R., Clinch River Breeder Reactor Plant steam generator: FEW tube test model post test examination, 5:24055 (CRBRP-GEFR-SP—176)
Inchagov, A.V., *See* Gryazev, V.M., 5:24060
Ingalls, R., Extended x-ray absorption fine structure of NaBr and Ge at high pressure, 5:24465
Ingle, B., *See* Liaw, M., 5:23816
Ingraham, J.C., *See* Massey, R.S., 5:25013
Innes, W.R., *See* Himel, T.M., 5:24840
Inokuti, M., *See* Matsuzawa, M., 5:24821
Inoue, T., *See* Kawabe, N., 5:23606
Ireland, J.R., *See* Kirchner, W.L., 5:24094
Israel, A., *See* Fowler, H., 5:24231
Ivanchenko, I.M., *See* Zhurkin, V.V., 5:24839
Ives, B.C., Boomtown impacts of energy development in the Lake Powell Region (Lake Powell Research Project), 5:24665 (PB—301221)
Ivy, J.T., Airborne aeroallergen measurements in Houston, Texas. Final report, 5:24602 (PB—299643)

J

Jackson, H.E., *See* Holt, R.J., 5:24897
Jackson, J.B., Chromatin fractionation procedure that yields nucleosomes containing near-stoichiometric amounts of high mobility group nonhistone chromosomal proteins, 5:24683
Jackson, K.L., Nevada geothermal commercialization planning. Semi-annual progress report, January 1, 1979-June 30, 1979, 5:23990 (DOE/ID/12019—1)
Jackson, W., Piezoelectric photoacoustic detection: Theory and experiment, 5:24575
Jacobs, D.G., Identification of technical problems encountered in the shallow land burial of low-level radioactive wastes, 5:23733 (ORNL/SUB—80/13619/1)
Jacobs, G.P., Contribution of endogenous and exogenous damage to the total radiation-induced damage in the bacterial spore, 5:24744 (DOE/EV/03221—64)
Jacobs, V.L., Multiple ionization and x-ray emission accompanying the cascade decay of inner-shell vacancies in Fe, 5:24828
See Rozsnyai, B.F., 5:24996
Jacoby, B.A., Optimized method of measuring directed electron velocities using the the incoherent regions of laser scattering, 5:24998
Jacoby, G.C. Jr, Lake Powell effect on Colorado River Basin water supply and environment (Lake Powell Research Project interim report), 5:24661 (PB—301068)
Jacoff, F.S., Bibliography of the Interagency Energy/Environment R and D Program, 5:24593 (EPA—600/9-79-015)
Fiscal Year 1977 Research Program Abstracts of the Interagency Energy/Environment R & D Program, 5:24594 (EPA—600/9-79-016)
Jacques, P.F., *See* Brick, D., 5:24854
Jaehne, H., Feasibility of a large district heating-cogeneration system for the Minneapolis-St. Paul area, 5:24189 (CONF-7910156—2)
Jahnig, C.E., Energy conversion system for deriving useful power from sources of low level heat, 5:23870
Jahnke, J.A., Continuous air pollution source monitoring systems, 5:24616 (PB—300930)
Jain, K.K., Structural properties of concrete with fly ash, 5:24461 (METC/SP—79/10(Pt.2), pp 522-543)
Jakovcic, S., Transcription of yeast mitochondrial deoxyribonucleic acid, 5:24684
Jalbert, R.A., *See* Carlson, R.V., 5:25068
James, S.D., *See* Larrick, B.F., 5:24161
Jantzen, D., Preliminary energy balance and economic of a farm-scale ethanol plant, 5:23775 (DOE/CS/4042—T36)
Janzen, A.F., *See* Seibert, M., 5:23844
Janzen, J.A., *See* Vantine, H.C., 5:24296
Jarboe, T.R., Production of field-reversed configurations with a magnetized coaxial plasma gun, 5:25049 (LA-UR—80-1104)
Jarmie, N., Low-energy nuclear fusion data and their relation to magnetic and laser fusion, 5:24890 (LA—8087)
Jaros, J.A., *See* Himel, T.M., 5:24840
Jeffreys, D., *See* Atallah, S., 5:23611
Jenkins, L.J., *See* Cowan, M.J., 5:23655
Jenkins, R.G., *See* Maloney, D.J., 5:23455
See Morgan, M.E., 5:23456
Jenni, P., *See* Himel, T.M., 5:24840
Jennings, S.J., *See* Westerberg, A.W., 5:23863
Jennison, D.R., Auger lineshape analysis of molecules and solids, 5:24965
Jensen, T., *See* Berg, D., 5:24841
Jensen, W.P., *See* Smartt, H.B., 5:24290
Jernigan, M.C., *See* Ullrich, R.L., 5:24748
Jhaveri, A.G., Overall city technology process. Final report, 5:24321 (PB—301109)
Jilek, G., *See* Fleet, C., 5:24282
Jiracek, G.R., Magnetotelluric soundings of crustal conductive zones in major continental rifts, 5:24789
Joebstl, J.A., *See* Walker, G.W., 5:24239
John, H., *See* Solbrig, C.W., 5:24081
Johnes, G.L., *See* Moss, G., 5:24506
Johnson, A.B. Jr., Spent fuel and fuel pool component integrity. Annual report, FY 1979, 5:23709 (PNL—3171)
Johnson, A.D., *See* Himel, T.M., 5:24840
Johnson, C.H., Measurement of the 2.35 MeV window in O + n, 5:24992 (CONF-791058—72)
Neutron total cross section of sulfur: Single level to multilevel to optical model, 5:24902
Johnson, D., *See* Kraft, D.C., 5:23496
Johnson, D.J., *See* Olsen, J.N., 5:24997
Johnson, E.L., Glass support light energy converter, 5:23830
Johnson, I., Fluidized-bed combustion process evaluation and program support. Quarterly report, October-December 1979, 5:23558 (ANL/CEN/FE—80-1)
Johnson, I.D., *See* Bruce, C.R., 5:23591
Johnson, J.H., The application of advanced mine air monitoring techniques to mines using diesel powered equipment. Annual report no. 2, January 1977-June 1978, 5:23569 (PB—300724)
Johnson, K., Simple model of the ground state of quantum chromodynamics, 5:24880
See Donoghue, J.F., 5:24870
Johnson, M., *See* Brick, D., 5:24854
See Sandweiss, J., 5:24851
Johnson, M.W., *See* Orth, C.J., 5:24899
See Wilcke, W.W., 5:24937
Johnson, N.R., *See* Yates, S.W., 5:24922
Johnson, R.A., Kinetics of two-state chemisorption: Hydrogen on niobium, 5:24400
Johnson, R.E., *See* Manasevit, H.M., 5:23804
Johnson, S.H., *See* Schiesser, W.E., 5:23423
Jokl, A.L., Power conditioners and fuel cell inverters, 5:24242
Jonath, A.D., Amorphous thin films for solar cell application. Final technical report, March 15, 1979-February 29, 1980, 5:23807 (DOE/ET/23040—4)
Jonckheere, A., *See* Berg, D., 5:24841
Jones, B.F. Jr., *See* Schwitzgebel, K., 5:23475
Jones, C., *See* Jhaveri, A.G., 5:24321
Jones, D.E., Performance of a packaged solar space-heating system used with a mobile home, 5:23890 (PB—300890)
Jones, G.J., Photovoltaic systems and applications perspective, 5:23820 (SAND—80-0926C)
Jones, J.B. Jr., Recent Paraho operations, 5:23642
Jones, P.L., *See* Cocks, F.H., 5:24454
See Fay, W.M., 5:23694
Jones, P.S., Procedures for multi-state multi-mode analysis: second year's research. Volume II. Final report, 5:24275 (PB—300814)
Jones, R., *See* Dew-Hughes, D., 5:24434
Jones, R.H., *See* Thomas, M.T., 5:24407
Jones, R.O., Economic issues in oil shale leasing policy, 5:23657
Jones, T.D., *See* Griffin, G.D., 5:24762
Jones, V.V., *See* Gaven, J.V. Jr., 5:23996
Jonke, A.A., *See* Johnson, I., 5:23558
Jorgenson, J.W., *See* Schultz, R.V., 5:23453
Joshi, R.C., Sources of pozzolanic activities in fly ashes: a critical review, 5:23490 (METC/SP—79/10(Pt.2), pp 610-623)
Joyce, T., *See* Berg, D., 5:24841
Juda, W., *See* Allen, R.J., 5:24498
Juhasz, A.J., *See* Springmann, H., 5:24222
Julienne, P.S., *See* Krauss, M., 5:24522
Jumel, Y., Properties of the LiCuO couple, 5:24147
Junga, F.A., *See* Jonath, A.D., 5:23807
Jurney, E.T., *See* Gladney, E.S., 5:23532
Justus, D., Mount Hood, Oregon, 5:23985

K

Kadyk, J.A., *See* Himel, T.M., 5:24840
Kaellne, J., (π,p) absorption in /sup 6,7/Li at 75 and 175 MeV, 5:24889
Kafalas, J.A., NASICON: a new solid electrolyte for Na/S batteries, 5:24158
See Hong, H.Y.P., 5:24435
Kahler, A.C., *See* Yates, S.W., 5:24922
Kaiser, R., Automotive manufacturers' cost/revenue, financial and risk analysis: projected impact of automobile manufacturing on the plastics industry. Final report June 1977-July 1978, 5:24181 (PB—300873)
Kaiser, W.M., Light-dark regulation of starch metabolism in chloroplasts. II.

Effect of chloroplastic metabolite levels on the formation of ADP-glucose by chloroplast extracts, 5:24706
Kaji, H., *See* Kawabe, N., 5:23606
Kalfoglou, G., Lignosulfonates carboxylated with cloroacetic acid as additives in oil recovery processes involving chemical recovery agents, 5:23588
Kalkstein, A., *See* Samuni, A., 5:24734
Kalpakjian, S., *See* Aronov, V., 5:24509
Kamakaris, D.G., Isopach map of black shale in the Sonyea Group (from well sample studies), 5:23618 (METC/EGSP—108)
Kammerud, R., *See* Place, W., 5:23886
Kan, Y.W., *See* Lebo, R.V., 5:24711
Kanabrocki, E.L., Instrumental analysis of trace elements in thumbnails of human subjects, 5:24484
Kanabrocki, J.A., *See* Kanabrocki, E.L., 5:24484
Kanavets, V.P., *See* Zhurkin, V.V., 5:24839
Kane, W.R., *See* Cizewski, J.A., 5:24932
Kaneko, H., *See* Okada, M., 5:24373
Kantro, D.L., Sulfate specifications as a constraint to gypsum addition to cement and possible replacement of gypsum as an additive. Phase I. Final quarterly technical progress report, December 1979-January-February 1980, 5:24292 (DOE/CS/40221—6)
Kaplan, E., *See* Kanabrocki, E.L., 5:24484
Kaplanis, S., *See* Stokstad, R.G., 5:24916
Kar, S., Evidence of tunnel-assisted transport in nondegenerate MOS and semiconductor-oxide-semiconductor diodes at room temperature, 5:24539
Karadi, G.M., Pumped storage development and its environmental effects. Final report Dec 1971-May 1974, 5:23794 (PB—299691)
Karant, Y.J., *See* Garpman, S.I.A., 5:24941
Karatas, C., *See* Ergun, S., 5:23836
Karnitz, M.A., *See* Jaehne, H., 5:24189
Karshon, U., *See* Brick, D., 5:24854
Karush, J.I., *See* Rodrique, G.H., 5:25114
Kasai, H., Floating-type anti-oil anti-impact anti-wave barrier, 5:23609
Kasha, H., *See* Morse, W.M., 5:24847
Kashiwa, B.A., *See* Brown, L.F., 5:23541
Kashuba, E., *See* Fleet, C., 5:24282
Kassen, D., *See* Egelhof, P., 5:24892
Kast, M., Solar production of industrial process steam for Stauffer Chemical Company, 5:23934 (SERI/TP—333-429, pp 327-334)
Kastenberg, W.E., *See* Badham, V.C., 5:25070
Katcoff, S., *See* Gilat, J., 5:24935
Kato, M., *See* Yonei, S., 5:24738
Kauffman, R.K., *See* Atwood, M.T., 5:23650
Kaufman, A.N., *See* Cary, J.R., 5:25038
Kaufman, G.E., *See* Fu, Y.K., 5:24779
Kaufman, R., Coping with energy limitations in transportation: proposals for Michigan, 5:24179 (PB—299737)
Kawabe, N., Method of transporting liquid pitch containing lumpy cokes and apparatus therefor, 5:23606
Kawai, T., *See* Uetani, Y., 5:24118
Kazama, Y., Dual formulation of non-Abelian gauge theories, 5:24856
Kearns, D.L., *See* O'Neill, E.P., 5:24032
See Ulerich, N.H., 5:24033
Keefer, R.F., Application of fly ash and other wastes to mine soils as an aid in revegetation, 5:23517 (METC/SP—79/10(Pt.2), pp 840-865)
Keeney, R.L., Formal analysis including value judgments and public risk, 5:24186 (UCRL—15226)
Keller, C.A., Distribution and excretion of lead in young and adult female mice, 5:24772
Lead transfer in maternal milk, and the absorption, retention, distribution and excretion of lead in suckling mice, 5:24771 (UR—3490-1798)
Keller, J., *See* Franke, F.H., 5:23433
Keller, R., *See* Loutfy, R.O., 5:24361
Kellermeyer, D.A., Climate and energy: a comparative assessment of the Satellite Power System (SPS) and alternative energy technologies, 5:23798 (DOE/ER—0050)
Kellogg, R., *See* Sandweiss, J., 5:24851
Kellogg, W.M., Modeling the prospects for climatic change: current state-of-the-art and implications, 5:24663 (CONF-800474—1)
Kellogg, W.W., Aerosols and climate, 5:24589 (CONF-800309—5)
Kelly, D.A., Solar power system, with high concentration, linear reflective solar panels, 5:23966
Kelly, E.M., *See* Russel, W.L., 5:24774
Kelly, W., Evaluation of the environmental effects of western surface coal mining. Volume II. Mine inventory. Final report, 5:23529 (PB—301249)
Kelsey, P.V. Jr., Water loss in fast project interim fuel storage rack, 5:24092 (EGG-FM—5078)
Kenik, E.A., HVEM in situ hydriding of hydrogen storage materials, 5:24394 (CONF-791132—5)
Kenley, R.A., *See* Hendry, D.G., 5:24623
Kennedy, G.C., *See* Ramakrishnan, J., 5:24396
Kennedy, W.E. Jr., *See* Napier, B.A., 5:24754
Kenworthy, L.D., Users manual data base MATSURV. Reactor pressure vessel material surveillance data management system, 5:24072 (ALO—63)
Kerker, M., *See* Bartholdi, M., 5:24576
Kerr, E.C., Fuel cleanup system for the tritium systems test assembly: design and experiments, 5:25069 (LA-UR—80-1273)
Kestner, M.O., Some properties of a highly ash-loaded cementitious binder, 5:23504 (METC/SP—79/10(Pt.2), pp 810-815)
Ketcham, H., *See* Merrick, E.T., 5:24621
Ketels, P.A., *See* Brown, K.C., 5:23910
Kevan, L., *See* Ogasawara, M., 5:24501
Key, J.L., *See* Silflow, C.D., 5:24699
Khan, A.M., Automobile mode: present status and future role, 5:24287
Khawaja, A.R., *See* Keefer, R.F., 5:23517
Khoe, T.K., *See* Arnold, R.C., 5:24551
Khoo, T.L., *See* Haas, B., 5:24923
Kiehl, R.A., Optically coupled microwave switch, 5:24570 (SAND—80-0029C)
Kiesling, C., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Kiesling, H.E., *See* Smith, G.S., 5:24331
Kilby, J.S., *See* Johnson, E.L., 5:23830
Kilroy, W.P., Chemistry of the Li/SO_2 battery: a review, 5:24143
See Angres, I.A., 5:24166
Kim, B., *See* Bracco, F.V., 5:23426
Kim, D.K., Coal liquefaction catalyst development. Quarterly progress report No. 3, October 1-December 31, 1979, 5:23438 (DOE/ET/14803—T4)
Kim, J., ISX-B neutral beam injector experiment on a prototype beam line, 5:24987
Kinabrew, C.B., *See* Cook, C.W., 5:24571
Kincannon, D.F., Some effects of western coal fly ash on municipal sewage sludge, 5:24313 (METC/SP—79/10(Pt.2), pp 898-903)
Kinder, D.L., Engineering approach for using power plant ash in a structural fill, 5:23497 (METC/SP—79/10(Pt.2), pp 713-724)
Impact of proposed RCRA regulations on resource recovery and utilization, 5:23463 (METC/SP—79/10(Pt.1), pp 45-50)
Kinelski, E.H., Biofouling, corrosion, and materials overview, 5:23864 (CONF-790631—(Vol.2), pp 12.1.1-12.1.3)
King, D.S., *See* Cox, A.N., 5:24795
King, L.A., *See* Erbacher, J.K., 5:24108
King, M.S., *See* Paulsson, B.N.P., 5:23731
King, N.S.P., *See* Winkelmann, E., 5:24891
Kinoshita, K., *See* Pierce, R.D., 5:24232, 5:24233
Kirchner, W.L., Fuel damage estimates for the TMI-2 reactor, 5:24094 (LA-UR—80-1069)
Kirczenow, G., Properties of the one- and two-component electron-hole liquid in stressed Si at T=0, 5:24470
Kirkbride, I., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Kirkpatrick, J.R., Numerical methods for the analysis of laser annealing of doped semiconductor wafers, 5:24368 (K/CSD/INF—79/27)
Kiselev, G.V., *See* Bakumenko, O.D., 5:24061
Kissell, F.N., Face ventilation system for coal mines, 5:23570
See Drivers, E.F., 5:23568
See Vinson, R.P., 5:23653
Kisslinger, L.S., Widths of Σ-hypernuclear states, 5:24872
Kistiakowsky, V., *See* Brick, D., 5:24854
Kittle, P.A., *See* Kestner, M.O., 5:23504
Kitts, F.G., *See* Armento, W.J., 5:23759
Klaffky, R.W., Radiation-induced conductivity of Al_2O_3: Experiment and theory, 5:24438
Klamerus, L.J., Cable tray fire tests, 5:24446 (EPRI-EL—1263, pp 9.1-9.31)
Klass, D.L., Energy from biomass and wastes: 1979 update, 5:23841
Klaus, D.M., *See* Foskett, W.A., 5:24639
Klein, M., *See* Charkey, A., 5:24113
Kligerman, M.M., *See* Richman, C., 5:24725
Klineberg, J.M., *See* Stucker, J.P., 5:24263
Klinedinst, K.A., *See* Domeniconi, M.J., 5:24121
Klingsporn, P.E., Semiautomated inspection of superfinished spherical surfaces, 5:24508 (BDX—613-2375)
Klopatek, J.M., Regional ecological assessment approach to atmospheric deposition: effects on soil systems, 5:24643 (CONF-791090—7)
Klouda, P., *See* Racine, D., 5:24784, 5:24785
Kmetko, E.A., *See* Roof, R.B., 5:24377
Knapp, C.A., *See* Fleming, R.B., 5:24534
Knauss, K.G., Review of geochemical measurement techniques for a nuclear waste repository in bedded salt, 5:23748 (UCID—18664)
Kniazewycz, B.G., Transuranic contaminated waste functional definition and implementation, 5:23751 (UCRL—15229)
Knight, J.D., *See* Orth, C.J., 5:24899
Knight, J.W., Research/Accelerators. Bimonthly status report of operations, November-December 1979. Volume 4, Number 6, 5:24555 (LBL-PUB—300)
Knight, P.G.K., *See* Dent, J.K., 5:23461
Knights, J.C., Defect states in plasma-deposited a-Si:H. Final report, February 1979-January 1980, 5:24457 (DOE/ET/23033—16)
Knudsen, J.F., *See* Jonath, A.D., 5:23807
Knudson, A.R., *See* Young, F.C., 5:24563
Koch, C., *See* Kuesebauch, W., 5:23771
Koch, C.C., *See* Easton, D.S., 5:24397
See Kroeger, D.M., 5:24404
Koch, D., *See* Schultz, H.L., 5:24617
Koch, P.M., *See* Gardner, L.D., 5:24824
Kocher, D.C., Calculation of dose-rate conversion factors for external exposure to photons and electrons, 5:24953 (CONF-7810133—6)

Iodine-129 dose to the world population from the nuclear power industry, 5:24628 (CONF-791103—107)
Kocur, G., *See* Louviere, J., 5:24284
Kocuvan, I., Hydration development of fly ash cements as measured by the NMR, 5:24462 (METC/SP—79/10(Pt.2), pp 564-569)
Koehler, H.A., Imaging system for obtaining space- and time-resolved plasma images on TMX, 5:24995 (UCRL—83805)
Koehler, P., *See* Berg, D., 5:24841
Koenig, H., *See* Kaufman, R., 5:24179
Koetzle, T.F., *See* Takusagawa, F., 5:24460
Kohler, J.T., Development of a site-fabricated building integrated air collector. Third quarterly report, March 31-June 30, 1978, 5:23946 (ALO—4123-T1)
Development of a site-fabricated, building integrated air collector. Interim report, September 30, 1077-March 31, 1978, 5:23948 (ALO—4123-T3)
See Coleman, J.J., 5:23947
Kohls, J.F., New technique for determining the parameters of gas permeation through solids, 5:24494 (GEPP-OP—474a)
Koizumi, C.J., Thin, dipping ore zone logging models. Log studies, 5:23676 (GJBX—54(80))
Kolanoski, H., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Koller, E.L., *See* Brick, D., 5:24854
Koller, G.R., Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
Kollman, W., *See* Partridge, R., 5:24842
Kollmann, W., *See* Peck, C.W., 5:24838
Kon'kov, V.F., *See* Gryazed, V.M., 5:24079
Kondrat'ev, V.I., *See* Gryazed, V.M., 5:24079
Korn, E.L., *See* Whittemore, A.S., 5:24776
Kostka, H., *See* Kuesebauch, W., 5:23771
Kovar, D.G., *See* Paul, M., 5:24904
See Prosser, F.W. Jr., 5:24906
See Sanders, S.J., 5:24905
Kozub, R., *See* Sanders, S.J., 5:24905
Kraft, D.C., Ash utilization in bikeway construction, 5:23496 (METC/SP—79/10(Pt.2), pp 694-712)
Krall, N.A., *See* Hamasaki, S., 5:25028
Kramer, C.M., Phase diagram of $NaNO_3$/KNO_3, 5:24458 (SAND—80-8502)
Kramer, J.M., *See* Schreyer, H.L., 5:24052
Kramer, S., *See* Mohiuddin, M., 5:24746
Kraus, R.M., *See* Forte, T.M., 5:24718
Krause, C., Socio-economic impacts of nuclear power plants, 5:24188
Krause, S.J., *See* Rogers, H.H., 5:24112
Krauss, M., Applied quantum chemistry advanced laser development. Final progress report, 1 October 1978-30 September 1979, 5:24522 (DOE/DP/40100—1)
Krauss, S.W., Fidelity of fractionated deoxyribonucleic acid polymerases from human placenta, 5:24696
Kraybill, H., *See* Brick, D., 5:24854
Kreith, F., Thermal storage and heat transfer in solar energy systems, 5:23975
Kreitler, C.W., *See* Gustavson, T.C., 5:23995
Kreitman, B., *See* Cohen, N., 5:24758
Kress, T.S., *See* Wright, A.L., 5:24086
Kretschmann, E., *See* Williams, M.W., 5:24412
Krichinsky, A.M., *See* Armento, W.J., 5:23759
Krinsky, S., Characteristics of synchrotron radiation and of its sources, 5:24557 (BNL—27678)
Krishnan, R.P., *See* Wells, J.W., 5:23559
Krishnaswamy, S.V., *See* Swab, P., 5:24411
Kristiansen, M., *See* Druce, R.L., 5:25037
Kroeger, D.M., Effect of strain upon the scaling law for flux pinning in bronze process Nb_3Sn, 5:24404
See Easton, D.S., 5:24397
Krogstad, R., *See* Petrasso, R., 5:24999
Krohm, G.C., *See* Guziel, K.A., 5:23564
Kron, A., *See* Goff, F., 5:23984
Kruer, W.L., *See* Estabrook, K.G., 5:24983
Krupa, J.F., *See* Schroeder, N.C., 5:23718
Kubono, S., 90° excitation functions for elastic scattering of $^{28}Si + ^{16}O$ and $^{28}Si + ^{12}C$, 5:24908
See Tserruya, I., 5:24907
Kucera, G.H., *See* Pierce, R.D., 5:24232, 5:24233
Kuehn, Ing.W., Oxidation techniques in Drinking water treatment. drinking water pilot project. Report IIa. Advanced treatment technology. Final report, 5:24666 (PB—301313)
Kuesebauch, W., Method for converting a reaction mixture consisting of hydrocarbon-containing fuel and an oxygen-containing gas into a fuel gas, 5:23771
Kukacka, L., *See* Zeldin, A., 5:24439, 5:24444
Kukacka, L.E., *See* Sugama, T., 5:24443
Kulak, R.F., *See* Schreyer, H.L., 5:24052
Kulakovskii, M.Ya., *See* Bakumenko, O.D., 5:24061
Kulchar, A.G., *See* Gilgenbach, R.M., 5:24988
Kumar, A., Oxidation of Ag^+ and $Ag(NH_3)_2^+$ as studied by pulse radiolysis, 5:24502
Kump, R.L., *See* Schultz, R.V., 5:23453
Kung, A.H., *See* Hess, P., 5:24822
Kunz, J., Flow patterns for collective rotations in heavy nuclei, 5:24920
Kupperman, D.S., Development of nondestructive evaluation techniques for high-temperature ceramic heat exchanger components. Tenth quarterly report, January-March 1980, 5:24507 (ANL/MSD/FE—80-2)
Kush, E.A., Hybrid photovoltaic/thermal systems with a solar-assisted heat pump, 5:23876 (BNL—27667)
Kustas, F.M., *See* Johnson, A.B. Jr., 5:23709
Kuswa, G.W., *See* Humphries, S. Jr., 5:24550

L

Labadie, J.W., Water management model for Front Range River Basins, 5:24008 (PB—299950)
Lacks, S.A., Effect of the composition of sodium dodecyl sulfate preparations on the renaturation of enzymes after polyacrylamide gel electrophoresis, 5:24675
Ladd, A.J.C., *See* Hoover, W.G., 5:24833
Lager, D.L., *See* Burke, G.J., 5:24538
See Lytle, R.J., 5:24787
Lagus, P.L., *See* Cook, C.W., 5:24571
Lahajnar, G., *See* Kocuvan, I., 5:24462
Lahart, M.J., Detection of perpendicular line intersections, 5:24541
Lai, L., *See* Horie, Y., 5:24613
Laibowitz, R.B., *See* Voss, R.F., 5:24516
Laine, E.F., *See* Lytle, R.J., 5:24787
Laing, W.R., Radioactive Materials Analytical Laboratory, 5:24488 (CONF-791103—111)
Laitner, S., Iowa solar applications: holding at the do-it-yourself level, 5:23873
Lajtha, L.G., Haemopoietic stem cells: concepts and definitions, 5:24730
Lake, R.W., *See* Law, C.E., 5:24273
Lamb, R.G., The calculation of long period mean pollutant concentrations in an urban atmosphere. Part II. Simulation of annual sulfur dioxide concentrations in Mexico City, 5:24605 (PB—299726)
Lambert, S.J., Strategy for evaluating the long-term stability of hole-plugging materials in their geological environments, 5:23743 (SAND—80-0359C)
Lamberton, B.A., Fly ash/cement grouts for mine backfilling, 5:23510 (METC/SP—79/10(Pt.2), pp 930-933)
Lambright, T.M., Cladding hull decontamination and densification process. Part 1. The prototype cladding hull decontamination system, 5:23702 (PNL—3166(Pt.1))
Land, R.E., *See* Hammelman, J.E., 5:24543
Lander, W.E.B., *See* Frantz, C.E., 5:24066
Landes, J.D., *See* McCabe, D.E., 5:23419
Landingham, R.L., Chemical vapor deposition of sialon, 5:24425
Silicon-nitride and metal composite, 5:24427
Landman, U., *See* De, G.S., 5:24959
Landry, E.F., Adsorption of enteroviruses to soil cores and their subsequent elution by artificial rainwater, 5:24726
See Vaughn, J.M., 5:24727, 5:24731
Lane, S.M., *See* Campbell, E.M., 5:23761
Lang, C., European contribution to heat exchanger design/performance: HTFS research and computer programs. Final report, 5:24510 (DOE/ET/12438—T1)
Lange, C.S., *See* Fu, Y.K., 5:24779
Langhoff, J., *See* Cornils, B., 5:23437
Langley, R.A., Initial testing of coated limiters in ISX-B, 5:25088 (CONF-800455—8)
See Clausing, R.E., 5:25094
See Whitely, J.B., 5:25092
Lanier, R.G., *See* Mann, L.G., 5:24921
Lankford, A.J., *See* Himel, T.M., 5:24840
Lanni, C., *See* Edwards, D. Jr., 5:24536
Lannutti, J.E., *See* Bugg, W.M., 5:24855
Laptev, V.D., New particle detector: a spark counter with localized discharge, 5:24564
Larimer, F.W., *See* Rao, T.K., 5:24765
Larrick, B.F., Lithium-boron alloy: a new battery anode material, 5:24161
Larsen, R.C., *See* Morse, W.M., 5:24847
Larsen, R.R., *See* Himel, T.M., 5:24840
Larson, B.C., X-ray study of lattice strain in boron implanted laser annealed silicon, 5:24478
Larson, D.B., Shock wave studies in Blair dolomite, 5:24793
Larson, D.T., AES and XPS study of plutonium oxidation, 5:24415
Larson, K.A., *See* Hepler, D.I., 5:23648
Larson, T., *See* Witkin, R., 5:23981
LaScola, J.C., *See* Drivers, E.F., 5:23568
Laszewski, R.M., *See* Holt, R.J., 5:24897
Latham, D.R., *See* Lawlor, D.L., 5:23630
Lathrop, J.W., *See* Johnson, E.L., 5:23830
Lau, Y.Y., Stability of shear flow in a magnetized plasma, 5:25021
Lauf, R.J., Dependence of silicon carbide coating properties on deposition parameters: preliminary report, 5:24050 (ORNL/TM—7209)
Lauterbach, M.J., *See* Morse, W.M., 5:24847
Law, C.C., Creep-rupture in powder metallurgical nickel-base superalloys at intermediate temperatures, 5:24389
Law, C.E., Rail as an industry, 5:24273
Law, C.K., Theoretical studies on heterogeneous combustion. Progress report, March 1, 1979-February 29, 1980, 5:24022 (COO—4433-3)
Lawlor, D.L., Post-burn study of the Rock Springs, Site 9 in situ retorting experiment, 5:23630
Lawrence, C.W., Ultraviolet-induced reversion of cyc1 alleles in radiation-

sensitive strains of yeast. III. rev 3 mutant strains, 5:24745
Lawrence, J.D., *See* Phillips, S.L., 5:23979
Lazarus, E., *See* Gilgenbach, R.M., 5:24988
Lazzarini, A.J., *See* Cosman, E.R., 5:24894
Lear, D.E. Jr, Granular filter, 5:24021
Lear, J.W., Long-life rechargeable silver-zinc battery, 5:24115
Long-term storage effects on sealed Ag-Zn cells, 5:24139
Leavitt, V.D., Soil profiles of mounds on plutonium-contaminated areas of the Nevada Test Range Complex, 5:24641 (EMSL-LV—0539-33)
Lebo, R.V., Assignment of human β-, γ-, and δ-globin genes to the short arm of chromosome 11 by chromosome sorting and DNA restriction enzyme analysis, 5:24711
Lechnick, W., Fly ash ponds, 5:23473 (METC/SP—79/10(Pt.1), pp 254-273)
Ledoux, R., *See* Cosman, E.R., 5:24894
Lee, C., Interaction of massless fermions with instantons, 5:24885
Lee, D.W., *See* Baes, C.F. Jr., 5:24036
Lee, H.C., *See* Olson, B.A., 5:24338
Lee, I.Y., *See* Yates, S.W., 5:24922
Lee, J.D, Tandem mirror fusion fission hybrid studies, 5:25064 (UCRL—84018)
Lee, L.M., Shock compaction of a porous pyrotechnic material, 5:24430 (SAND—80-0427C)
Lee, P., *See* Minerbo, G.N., 5:25080
Lee, P.H., *See* Campbell, E.M., 5:23761
Lee, P.H.Y., *See* McClellan, G., 5:24951
Leedecke, C.J., Glass-ceramics for lightning arrestor connector seals, 5:24429 (SAND—80-0215)
Leeper, R.J., *See* Olsen, J.N., 5:24997
Lefler, K.A., *See* Heisterberg, R.H., 5:24848
Legg, K.O., *See* Metz, W.A., 5:24806
Lehmberg, R.H., *See* Ripin, B.H., 5:25082
Leipuner, L.B., *See* Morse, W.M., 5:24847
Leitnaker, J.M., Delta ferrite-containing austenitic stainless steel resistant to the formation of undesirable phases upon aging, 5:24360
Lekas, M.A., Progress report on the geokinetics horizontal in situ retorting process, 5:23631
Lemmon, A.W. Jr, Environmental assessment of coal cleaning processes; first annual report. Volume I. Executive summary. Annual report July 1976-September 1977, 5:23526 (PB—300671)
Environmental assessment of coal cleaning processes; first annual report. Volume II. Detailed report. Annual report July 1976-September 1977, 5:23527 (PB—300672)
Leon, M., *See* Borie, E., 5:24818
Leonard, G.J., *See* Schottler, G.R., 5:23662
Leonard, J.P., *See* Philpot, J.A., 5:23791
Leonard, R.L., *See* White, I.L., 5:23668
Lepman, S.R., *See* Phillips, S.L., 5:23979
Leroy, J., *See* Aubeau, R., 5:24493
Lesieur, R.R., Process for alternately steam reforming sulfur containing hydrocarbons that vary in oxygen content, 5:23610
Leung, K.C., *See* Smith, D.E.A., 5:24853
Levi, M.E., *See* Himel, T.M., 5:24840
Levin, F.S., Wave-function formalisms in the channel coupling array theory of many-body scattering, 5:24942
See Greben, J.M., 5:24946
Levine, C.A., *See* Tsang, F.Y., 5:24124
Levine, E.P., Comparative assessment of environmental welfare issues associated with the satellite power system (SPS) and alternative technologies, 5:23849 (DOE/ER—0055)
See Cirillo, R.R., 5:23850
LeVine, M.J., *See* Paul, M., 5:24904
Levinson, H.J., Enhanced photoexcitation from the surface of aluminum, 5:24409
Levis, A.H., ALINET: a model for assessing energy conservation opportunities in the food processing industry. Final technical report, September 1977-December 1979, 5:24298 (DOE/CS/40021—1)
Levis, I.S., *See* Levis, A.H., 5:24298
Levis, R.E., *See* Akutagawa, W.M., 5:24721
Levy, A., Project evaluation and quality control, 5:24262 (PB—301048)
Weatherization training; a notebook for weatherization. Supplement Number 3: transportation, 5:24256 (PB—301143)
See Brick, D., 5:24854
Levy, A.V., *See* Lamb, R.G., 5:24605
Levy, E. Jr., *See* Rogers, H.H., 5:24112
Lewis, A.V., *See* Hodby, J.W., 5:24468
Lewis, H.D., Thermal conductivities of mixed carbide fuel and blanket materials, 5:24058 (LA-UR—80-1283)
Lewis, M.B., Ion beam technique for the measurement of deuterium diffusion coefficients, 5:24359
Lewis, P.A., BEST Facility: accelerating the development of utility load-leveling batteries, 5:24163
Lewis, W.E., *See* Allan, D.E., 5:23595
Lewontin, R.C., Study of mathematical models of mutation and selection in multi-locus systems. Annual progress report, April 1, 1979-March 31, 1980, 5:24667 (DOE/EV/02472—6)
Leyerle, R.W., New H_3PO_4 fuel cell electrocatalysts made from alumina/pyropolymer composites, 5:24241
Li, C., *See* Heisterberg, R.H., 5:24848
Li, C.T., Process for purifying geothermal steam, 5:23992
Li, H.W., *See* Abdel Khalik, S.I., 5:23972
Li, J.C.M., *See* Chu, S.N.G., 5:24532
Liaw, M., Sequential purification and crystal growth for the production of low cost silicon substrates. Quarterly technical progress report No. 1, 15 September 1979-31 December 1979, 5:23816 (DOE/SERI—8119-3/1)
Liberman, A., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Lichtenstadt, J., Investigation of natural-parity high-spin states in ^{208}Pb by (e,e') reactions, 5:24931
Liddle, S.G., Electric and Hybrid Vehicle System Research and Development Project: hybrid vehicle potential assessment. Volume V. Flywheel systems, 5:24349 (CONS—4209-T1(Vol.5))
Liebman, S.W., Mutator affecting the region of the iso-1-cytochrome c gene in yeast, 5:24712
Lienau, P.J., Potato processing, 5:24000
Liepins, G.E., *See* Blue, J.L., 5:24244
Liesen, D., Experimental confirmation of a scaling law for the 1sσ excitation probability for $Z_1+Z_2>120$, and its breakdown in Pb+Cm collisions at very small internuclear distances, 5:24827
Lihach, N., Continuing disposal of coal ash, 5:24029
Delicate disposal of PCBs, 5:24030
Lilienfeld, P., Improved light scattering dust monitor. Open file report (final) 3 August 1977-31 May 1978, 5:24569 (PB—299938)
Lilley, J.S., *See* Franey, M.A., 5:24933
Lim, K.J., *See* Waterland, L.R., 5:24547
Lin, A., *See* Dzurinko, E.P., 5:23474
Lin, A.L., *See* Lechnick, W., 5:23473
Lin, R.P., *See* Potter, D.W., 5:24797
Lind, D.A., *See* Alford, W.P., 5:24918
Lind, M.A., *See* Coyle, R.T., 5:23960
Lindau, I., *See* Skeath, P., 5:24381
Lindgren, F.T., *See* Forte, T.M., 5:24718
Lindmayer, J., Terrestrial photovoltaic design: a new experience in systems thinking, 5:23855
Lindstrom, R., *See* Atallah, S., 5:23611
Lindstrom, R.W., *See* Allen, R.J., 5:24498
Linehan, P.W., *See* Wiss, J.F., 5:23519, 5:23520, 5:23521, 5:23522
Linford, H.B., *See* Szostak, R.M., 5:24326
Linford, R.K., *See* Jarboe, T.R., 5:25049
Linhardt, H.D., Investigation of high velocity wedge separator for particle removal in coal gasification plants. Quarterly report, 5:23412 (FE—2709-T1)
Link, J.M., Pipeline transportation of oil shale, 5:23644
Linn, S., *See* Krauss, S.W., 5:24696
Linville, B., Contracts for field projects and supporting research on enhanced oil recovery and improved drilling technology. Progress review No. 21, quarter ending December 31, 1979, 5:23576 (DOE/BETC—80/1)
Lipinsky, E.S., *See* Fink, D.J., 5:23833
Lipkin, H.J., Troubles with nonleptonic charm decays, 5:24866
Lipkin, J., *See* Grady, D.E., 5:24792
Lippek, H.E., Selected regulatory issues affecting coal transportation requirements, 5:23550
Lipsztein, J., Improved mathematical model for uranium metabolism, 5:24753 (COO—3382-18, pp VII.1-VII.12)
See Neton, J., 5:24760
Liscinsky, D.S., Evaluation of an Automated Reflectance Microscope system for coal characterization. Technical report 18, 5:23454 (FE—2030-TR18)
Litchfield, J.H., *See* Fink, D.J., 5:23833
Littauer, E.L., *See* Bauman, H.F., 5:24119
Littenberg, L.S., K/sub S/** and its uses, 5:24860
Liu, C.S., *See* Lau, Y.Y., 5:25021
Liu, C.T., Fe-based long range ordered alloys, 5:24363
See Bryant, W.A., 5:24114
Livesay, B.R., *See* Kenik, E.A., 5:24394
Ljung, D., *See* Brick, D., 5:24854
See Sandweiss, J., 5:24851
Lloyd, A.C., *See* Lurman, F., 5:24611
See Lurmann, F., 5:24612
Lobit, J., *See* Smith, S.E., 5:23916
Lobkowicz, F., *See* Berg, D., 5:24841
Lobov, G.A., Weak interaction of nucleons in the Weinberg-Salam model, 5:24863 (LA-tr—80-11)
Loeffel, R., *See* Solbrig, C.W., 5:24081
Logan, B.G., *See* Baldwin, D.E., 5:24977
Loire, R., *See* Pagezy, M.J., 5:23581
Long, A.B., Assessment of new instrumentation and control technologies. Remote multiplexing. A case study, 5:24077
Longua, K.J., Ultrasonic inspection of liquid-metal fast breeder reactor steam generator duplex tubing, 5:24063
Lonngren, K.E., Self similar solution of plasma equations, 5:25012
Lookadoo, P.G., *See* Cordell, K.R., 5:24900
Loring, C.M., *See* Gilgenbach, R.M., 5:24988
Louis, J.F., Coal combustion studies, 5:24226 (FE—2215-13(Vol.1), pp 282-394)
Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978, 5:24215 (FE—2215-13(Vol.1))
Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978, 5:24216 (FE—2215-13(Vol.2))
Critical phenomena in MHD generators, 5:24227 (FE—2215-13(Vol.2), pp 395-480)

Electrode module materials evaluation, 5:24223 (FE—2215-13(Vol.1), pp 28-109)
Electrode module development, 5:24225 (FE—2215-13(Vol.1), pp 134-281)
MHD component and system modeling, 5:24219 (FE—2215-13(Vol.2), pp 597-684)
MHD generator modeling, 5:24228 (FE—2215-13(Vol.2), pp 685-707)
Studies in a disk generator, 5:24220 (FE—2215-13(Vol.2), pp 481-596)
Superconducting magnet fabrication development, 5:24224 (FE—2215-13(Vol.1), pp 110-133)
U-25 electrode development program, 5:24229 (FE—2215-13(Vol.2), pp 847-859)
Loutfy, R.O., Method of winning aluminum metal from aluminous ore, 5:24361
Photovoltaic cell, 5:23827
Photovoltaic cell comprising metal-free phthalocyanine, 5:23828
Louviere, J., Analysis of user cost and service trade-offs in transit and paratransit services, 5:24284 (UMTA-MA—06-0049-79-10)
Loveland, W., *See* Morrissey, D.J., 5:24926
Lowdermilk, W.H., Multipass amplifier: Theory and numerical analysis, 5:24526
Lowe, J.A., *See* Rose, J.G., 5:24035
Lowe, K.H., *See* Blue, J.L., 5:24244
Lower, J.D., *See* Phaup, C.W., 5:23585
Lowndes, D.H., k dependence of the conduction-electron—local-moment exchange interaction in the atomic and covalent-mixing limits, 5:24402
Lowry, W.E., *See* Altenbach, T.J., 5:23710
Lucas, J.W., Point-focus collector technology for IPH, 5:23938 (SERI/TP—333-429, pp 385-390)
Lucas, P., *See* Brick, D., 5:24854
Lucey, R., *See* Gilgenbach, R.M., 5:24988
Luckenbach, E.C., Process for regenerating metal-contaminated hydrocarbon conversion catalysts, 5:23590
Luddy, W., *See* Carlton, R., 5:23955
Ludlam, a., *See* Sandweiss, J., 5:24851
Ludlam, I., *See* Brick, D., 5:24854
Lueth, V., *See* Himel, T.M., 5:24840
Lundberg, L.B., Method of forming single crystals of beta silicon carbide, 5:24426
Lunk, H.E., *See* Bremner, R.O., 5:24447
Lupton, W.H., *See* Burton, J.K., 5:25056
Lurie, N.A., Best-estimate LOCA radiation signature for equipment qualification, 5:24097 (SAND—80-0888C)
Lurman, F., A lagrangian photochemical air quality simulation model: adaptation to the St. Louis - Raps Data Base. Volume I. Model formulation. Final report, 5:24611 (PB—300470)
Lurmann, F., A lagrangian photochemical air quality simulation model: adaptation to the St. Louis - Raps Data Base. Volume II. User's manual. Final report, 5:24612 (PB—300471)
Luton, J.N., *See* Haubenreich, P.N., 5:25047
Lutz, H.A. III, *See* Strongin, M., 5:24367
Lytle, R.J., Cross-borehole electromagnetic probing to locate high-constrast anomalies, 5:24787
See Burke, G.J., 5:24538
Lytton, M., *See* Cox, D., 5:24308

M

Ma, I.C., *See* Holt, J.G., 5:24954
Maass, K.P., 1 kW tungsten carbide fuel cell power plant with a methanol cracker, 5:24235
Macal, C.M., *See* Guziel, K.A., 5:23564
Macek, R.J., *See* Highland, V.L., 5:24843
Macfarlane, M.H., *See* Rhoades-Brown, M., 5:24943, 5:24944
Machanoff, R., *See* Hsie, A.W., 5:24763
Machiels, A.J., *See* Olander, D.R., 5:23732
MacMillan, H.F., *See* Jonath, A.D., 5:23807
Macphail, M.R., *See* Cizewski, J.A., 5:24932
MacRae, R.A., *See* Petrakian, J.P., 5:24398
Maddigan, R.J., Price incentives of industrial cogeneration, 5:24305 (CONF-800548—1)
Maddux, S.C., *See* Russel, W.L., 5:24774
Madsen, H.C., National environmental models of agricultural policy, land use and water quality. Progress report no. 4, 5:24649 (PB—300525)
Madsen, N.K., *See* Rodrique, G.H., 5:25114
Madsen, V.A., *See* Finlay, R.W., 5:24915
Maeda, B.T., Suncatcher Monitoring Project. Quarterly technical report 1, October-December 1977, 5:23880 (DOE/CS/34154—1)
Suncatcher Monitoring Project. Quarterly technical reports 2 and 3, January-June 1978, 5:23881 (DOE/CS/34154—2-3)
Maerker, R.E., *See* Wagschal, J.J., 5:24070
Mahin, K.W., Comparative analysis of the cellular and Johnson-Mehl microstructures through computer simulation, 5:24376
Mahoney, J.A., *See* Kim, D.K., 5:23438
Majidzadeh, K., Material characteristics of power plant bottom ashes and their performance in bituminous mixtures: a laboratory investigation, 5:23502 (METC/SP—79/10(Pt.2), pp 787-804)
Majka, R., *See* Sandweiss, J., 5:24851
Majoros, S., *See* Deans, H.A., 5:23573
Majumdar, S., Analysis of an internally pressurized prismatic cell can, 5:24156 (ANL—80-30)
Makdisi, Y., *See* Berg, D., 5:24841
Makuchowski, E.J., *See* Bionta, R.M., 5:24852
Maley, M.P., LASL Nb_3Ge conductor development. Fourteenth quarterly progress report, October 1-December 31, 1979, 5:24969 (LA—8320-PR)
Mali, V.I., *See* Zakharenko, I.D., 5:24371
Malik, R.K., Process for treating weldments, 5:24365
Maloney, D.J., Effects of preoxidation on the swelling and softening of bituminous coals, 5:23455 (FE—2030-TR20)
Malsheimer, S.S., *See* Costello, V.A., 5:23977
Manasevit, H.M., Thin films of InP for photovoltaic energy conversion. Second quarterly technical progress report, September 29, 1979-December 28, 1979, 5:23804 (COO—3004-2)
Manheimer, W.M., Shear stabilized cylindrically symmetric mirror plasma, 5:25031
See Colombant, D.G., 5:25014
Manickam, J., *See* Dewar, R.L., 5:25026
Mann, L.G., Decay of ^{180}Re: Search for octupole states in ^{180}W, 5:24921
Mansur, L.K., Effective diffusion coefficients of point defects in impure materials, 5:24375 (ORNL/TM—7247)
Manz, O.E., Disposal of high alkaline fly ash sludge in a decoaled mine seam, 5:23505 (METC/SP—79/10(Pt.2), pp 866-872)
Marciano, W.J., Exotic new quarks and dynamical symmetry breaking, 5:24874
Margen, P., *See* Jaehne, H., 5:24189
Marincic, N., Performance characteristics of large primary $Li/SOCl_2$ cells, 5:24150
Marinello, S., *See* Doscher, T., 5:23577
Markarian, R.K., *See* Tolle, D.A., 5:23528
Marker, D., Optimized polynomial expansions: potentials and phase shift analyses, 5:24871 (DOE/ER/10516—T3)
Markin, S.A., *See* Gryazev, V.M., 5:24060
Markin, T.L., $LaNi_5$ electrodes in nickel-hydrogen batteries, 5:24164
Marland, G., *See* Baes, C.F. Jr., 5:24036
Marli, F., *See* Schultz, R.V., 5:23453
Marling, J.B., Deuterium separation at high pressure by nanosecond CO_2 laser multiple-photon dissociation, 5:24497
Marmar, E.S., *See* Razdow, A.M., 5:25101
Maron, N., *See* Cohen, B.I., 5:25029
Marr, R.B., Overview of image reconstruction, 5:25105 (BNL—27665)
Marsh, R.A., *See* Ryan, D.M., 5:24128
Marshak, M., *See* Berg, D., 5:24841
Marshall, J., *See* Jarboe, T.R., 5:25049
Marshall, H.P., Performance of a diesel engine operating on raw coal-diesel fuel and solvent refined coal-diesel fuel slurries. Final report, 5:24335 (CONS—3288-T6)
Marsland, D.B., *See* Baldwin, V.H., 5:24315
Martin, M.J., ENSDF: its structure, contents, and use in applied research, 5:24886 (CONF-791243—1)
Martin, R.L., *See* Arnold, R.C., 5:24551
Martin, T.J., *See* Turner, A.P.L., 5:24388
Marvin, H.H., Overview of DOE's solar energy programs, 5:23795
Maskarinec, M.P., *See* Schultz, R.V., 5:23453
Maslen, P.L., *See* Dunlay, J.B., 5:24336
Massey, M.J., *See* Fillo, J.P., 5:23420
Massey, R.S., Measurements of electron heat flow along a dc magnetic field in strong temperature gradients, 5:25013 (LA-UR—80-1109)
Mast, P.K., *See* Kirchner, W.L., 5:24094
Masterson, K.D., National solar optical materials program plan: an overview, 5:23961 (SERI/TP—641-619)
Masuyama, A., Steady-state thermally annealed GaAs with room-temperature-implanted Si, 5:24479
Mater, J., Utilizing bark and wood residues to solve technical problems, 5:24320
Matsuzawa, M., Integrals of the squared atomic form factor over the momentum transfer, 5:24821
Matta, J.E., *See* Kissell, F.N., 5:23570
Mattern, M.R., Dependence of mammalian DNA replication on DNA supercoiling. I. Effects of ethidium bromide on DNA synthesis in permeable Chinese hamster ovary cells, 5:24691
Dependence of mammalian DNA replication on DNA supercoiling. II. Effects of novobiocin on DNA synthesis in Chinese Hamster ovary cells, 5:24700
Production and excision of thymine damage in the DNA of mammalian cells exposed to high-LET radiations, 5:24737
Matthews, T.G., Formaldehyde monitoring program: development of sampling and analysis procedures. Report to the Consumer Product Sampling Commission, 5:24592 (DOE/TIC—11203)
Mattisson, I., Wave measuring project for wave energy prospecting purpose, 5:24001 (SMHI-HBF-PM—229)
Mattox, D.M., Preparation of thin films for solar energy utilization, 5.23825

Survey of selective solar absorbers and their limitations, 5:23954 (SAND—79-2371C)
See Mullendore, A.W., 5:25093
Maudlin, P.J., Neutron and fuel cycle kinetics analogy, 5:24187 (CONF-791103—110)
Maupoux, M., *See* Smith, C.C., 5:23915
Mauro, P.G., The effects of primary power transmission lines on the performance of LORAN-C receivers in experimental terrestrial applications. Final report May-July 1979, 5:24040 (PB—301367)
Maxwell, D.E., *See* Young, C., 5:23638
Mayer, A., Development of Megasonic cleaning for silicon wafers. Quarterly report No. 4, 5:23814 (DOE/JPL/955342—4)
Mayes, W.W., High severity process for the production of aromatic hydrocarbons, 5:23598
Mayhall, D.J.T., Computer based electrical analysis of homopolar generator driven, bitter plate storage inductors with radial current diffusion, 5:25058
Maynard, C.W., *See* Ragheb, M.M.H., 5:25083
Mayne, J., *See* Morrall, J., 5:24288
Mazur, P., Limits to life at low temperatures and at reduced water contents and water activities, 5:24702 (CONF-7810136—2)
McBrayer, J., *See* Haynes, R., 5:23571
McBride, J.B., *See* Hamasaki, S., 5:25028
McBride, P., *See* Sandweiss, J., 5:24851
McCabe, D.E., Design properties of steels for coal conversion vessels. Interim report, 5:23419 (EPRI-AF—1242)
McCarthy, J.F., Changes in ecdysteroids during embryogenesis of the blue crab, callinectes sapidus rathbun, 5:24687
McCarthy, J.S., *See* Kaellne, J., 5:24889
See Lichtenstadt, J., 5:24931
McCarthy, W., *See* Thoem, T., 5:23669
McCauley, J.W., *See* Wong, P., 5:24126
McClellan, G., Z dependence of the laser-intensity threshold for inhibited electron thermal conduction, 5:24951
McConaghy, C.F., Noise characterization of the linear CCD, 5:24572 (UCID—18622)
McConnell, R.D., Screening method for wind energy conversion systems, 5:24003 (SERI/TP—731-649)
McCormick, J.R., Development of a polysilicon process based on chemical vapor deposition (Phase 1). First quarterly progress report, 6 October-31 December 1979, 5:23815 (DOE/JPL/955533—79/1)
See Hopkins, R.H., 5:23809, 5:23810
McCormick, P.O., Performance of a solar heating system for kiln drying lumber, 5:23922 (SERI/TP—333-429, pp 215-229)
McCracken, C., Land use controls to save energy, 5:24260
McCracken, G.M., *See* Dylla, H.F., 5:25097
See Wampler, W.R., 5:25004
McCreary, W.J., Coated woven materials and method of preparation, 5:24453
McCreight, L.R., *See* Fedarko, W., 5:23413
McCulloch, W.H., Test experience at the DOE/Sandia Midtemperature Solar Systems Test Facility, 5:23956 (SERI/TP—333-429, pp 133-137)
McCullough, J.F., Uranium recovery from wet-process phosphoric acid, 5:23700
McCurdy, C.W., Complex-basis-function calculations of resolvent matrix elements: Molecular photoionization, 5:24829
McDermott, J.J., *See* Van Voast, W.A., 5:23530
McDermott, P.P., Failure analysis of cells in an accelerated test program, 5:24131
McDonald, G.D., Commercializatzon of thick film solar cells. Quarterly progress report, September 21, 1979-December 31, 1979, 5:23817 (DSE—4042-T17)
McDonald, J.C., *See* Holt, J.G., 5:24954
McDowell, W.J., Alpha liquid scintillation counting: past, present, and future, 5:24560 (CONF-790859—3)
New advanced in alpha spectrometry by liquid scintillation methods, 5:24559 (CONF-791117—26)
See Seeley, F.G., 5:23470
McElroy, J.F., Assessment of the solid polymer electrolyte fuel cell for mobile power plants, 5:24238
McFall, A.L., Directional drilling in tar sands, 5:23620 (SAND—80-1134)
McFarlane, W.K., *See* Highland, V.L., 5:24843
McFerren, J.S., *See* Johnson, E.L., 5:23830
McGann, R., *See* Paull, P.L., 5:23772
McGean, T.J., *See* Stevens, R.D., 5:24343
McGlone, R.B., *See* Braendlein, R.K., 5:24339
McGowan, E.J., *See* Bremner, R.O., 5:24447
McGrievy, L.H., *See* Bruce, C.R., 5:23591
McIntyre, L.F., *See* Loutfy, R.O., 5:23828
McIsaac, L.D., *See* Schroeder, N.C., 5:23718
McKechnie, R.M., *See* Jokl, A.L., 5:24242
McKilligan, K.J., Design and evaluation of solar powered residential domestic water heaters, 5:23943
McKinnon, T., *See* Jantzen, D., 5:23775
McLaughlin, A.C., Rapid ATP assays in perfused mouse liver by ^{31}P NMR, 5:24697
See Cohen, S.M., 5:24717
McLean, E.A., *See* Ripin, B.H., 5:25082
McLean, E.T., Hillman State Park: final assessment of fly ash as a soil modifier for acidic strip mine spoil, 5:23516 (METC/SP—79/10(Pt.2), pp 816-839)
McLean, M.B., *See* Frank, H.A., 5:24678
McLean, R.L., *See* Holmes, C.F., 5:24148
McMahon, J.M., *See* Ripin, B.H., 5:25082
McMillan, A., *See* Whittemore A.S., 5:24751
McNamara, B., *See* Boyd, J.K., 5:25018
McNamara, P.H., Characterization, fracturing, and true in situ retorting in the Antrim shale of Michigan, 5:23634
McNaughton, M.W., *See* Winkelmann, E., 5:24891
McNeany, S.R., *See* Allen, E.J., 5:24483
McNeese, L.E., Coal, 5:23533 (CONF-790949—3)
Mead, W.J., *See* Jones, R.O., 5:23657
Medville, D.M., *See* Mendis, M.S., 5:23537
See Rosenberg, J.I., 5:23536
Mehrhoff, T.K., Gettering of carbon dioxide by erbium thin films, 5:24495 (GEPP-OP—482)
Mehta, A.J., *See* Schuhmann, R. Jr, 5:23414
Meissner, D.C., Method for the direct reduction of iron using gas from coal, 5:23431
Meldner, H.M., *See* Cusson, R.Y., 5:24927
Mendel, C.W., *See* Burns, E.J.T., 5:24481
See Humphries, S. Jr., 5:24550
Mendis, M.S., Manpower for the coal mining industry: an assessment of adequacy through the year 2000. Volume II. Technical approach. Final technical report, 5:23537 (FE—3134-2)
See Rosenberg, J.I., 5:23536
Menon, M.M., Development of the ion source for PDX neutral beam injection, 5:25063 (CONF-791102—161)
See Kim, J., 5:24987
Menotti, F., *See* Mohnen, V.A., 5:24619
Merkel, R.T., Advances in marketing Pozzolanic road bases, 5:23503 (METC/SP—79/10(Pt.2), pp 805-809)
Merljak, P., *See* Kocuvan, I., 5:24462
Merrick, E.T., Epa chemical activities status report, first edition, 5:24621 (PB—301366)
Merrigan, M., Ceramic heat pipe development. Quarterly report, January 1-March 31, 1980, 5:24511 (DOE/TIC—11192)
Merrill, J.T., Improved method and apparatus for electrostatically sorting biological cells, 5:24701
Merz, W.C., *See* Ebner, W.B., 5:24146
Messier, R., *See* Swab, P., 5:24411
Metcalfe, C.E., *See* Matthews, T.G., 5:24592
Metraller, W.J., *See* Allan, D.E., 5:23595
Metz, W.A., Auger spectra induced by 100-keV Ar^+ impact on Be, Al, and Si, 5:24806
Meyer, A.P., 1.5-kW methanol fuel cell power plant system design study, 5:24236
Meyer, B.A., Natural convection heat transfer in small and moderate aspect ratio enclosures: an application to flat plate collectors, 5:23973
Meyer, C.F., Evaluation of thermal energy storage for a large urban hot water district heating system in the United States, 5:24101 (CONF-7910152—1)
Meyer, H.R., *See* Till, J.E., 5:23704
Meyer, R.A., Level properties of $^{85}_{37}Rb_{48}$ from the decay of the ^{85}Kr and ^{85}Sr isomers and the cluster-vibration model, 5:24913
Meyer, S.F., *See* Burt, R.J., 5:24809
Meyer, W., Effects of seepage from fly-ash settling ponds and construction dewatering on ground-water levels in the Cowles Unit, Indiana Dunes National Lakeshore, Indiana. Water-resources investigations (final) 1976-77, 5:24660 (PB—300843)
Meyers, C.D., Analysis of environmental factors affecting technology deployment: a case study, 5:24027 (DOE/RA/10001—T1)
Michaelson, S.M., *See* Guillet, R., 5:24716
Michalek, R., *See* Collins, M.F., 5:23764
Micheletti, W.C., Summary of equilibrium and process model data acquisition: treatment of recirculated cooling water, Resource Document 1. Interim report, 5:24007 (EPRI-FP—1251)
Midurski, T.P., Evaluation of motor vehicle emissions inspection and maintenance programs in Minnesota. Final report, 5:24353 (PB—301162)
Mielenz, R.C., Specifications on fly ash for use in concrete: where we are - where should we go, 5:23484 (METC/SP—79/10(Pt.2), pp 482-495)
Mies, F.H., *See* Krauss, M., 5:24522
Migliori, A., General critical state model in two dimensions and zero applied field: A uniqueness theorem and some consequences, 5:24968
Mignon, G.V., *See* Smith, S.E., 5:23916
Miles, C.V., Security problems in the rail transportation of coal, 5:23556
Miles, J.C., *See* Greening, P.A.K., 5:24289
Miller, C.W., *See* Fields, D.E., 5:24633
Miller, E.K., *See* Burke, G.J., 5:24538
Miller, M.E., Modulation of erythropoietin concentrations by manipulation of hypercarbia, 5:24690
Miller, M.W., *See* Fu, Y.K., 5:24779
Miller, R.C., Oncogenic transformation of mammalian cells in vitro with split doses of x rays, 5:24740
See Bronzini, M.S., 5:24279
Miller, T.L., *See* Eastman, J.M., 5:25072
Millikan, R.E., *See* Himel, T.M., 5:24840
Mills, J., Seven DOE intermediate temperature (350°F to 550°F) steam

demonstration projects, 5:23907 (SERI/TP—333-429, pp 47-54)
Mills, J.D., *See* Crowther, D., 5:24686
Milnarist, L.P., *See* Mumma, S.A., 5:23944
Milton, K.A., Zero-point energy of confined fermions, 5:24867 (DOE/ER/01545—274)
Min, D.K., *See* Carew, J.F., 5:24073
Minerbo, G.N., Three-dimensional reconstruction of the x-ray emission in laser imploded targets, 5:25080
Minnick, L.J., Role of fly ash in structural types of stabilized applications, 5:23478 (METC/SP—79/10(Pt.1), pp 344-356)
Mitchell, D.J., Photophysics of organic molecules at high pressure, 5:24499 (DOE/ER/01198—1305)
Mitchell, H.L., *See* Butz, T.R., 5:23690
Mitchell, J., *See* Kreith, F., 5:23975
Mitchell, J.W., *See* Meyer, B.A., 5:23973
Mitchell, P.D., Textile drying at WestPoint Pepperell using solar process steam, 5:23925 (SERI/TP—333-429, pp 245-249)
Mitsuoka, S., *See* Matsuzawa, M., 5:24821
Miwa, N., *See* Kawabe, N., 5:23606
Mlekodaj, R.L., *See* Spejewski, E.H., 5:24552
Mo, L.W., *See* Heisterberg, R.H., 5:24848
Moddeman, W.E., Role of surface chemistry in the ignition of pyrotechnic materials, 5:24580 (MLM—2708(OP))
Moede, L.W., *See* DeLuca, W.H., 5:24154
Moeller, P., *See* Cusson, R.Y., 5:24927
Moens, T.A., *See* Applegate, J.K., 5:23987
Mohamed, H.A., Equilibrium transition temperature of thermoelastic martensitic transformations, 5:24382
Mohiuddin, M., Results of a pilot study with extended fractionation in the treatment of lung cancer, 5:24746
Mohler, J., Power independent ignition energy measurements, 5:24581 (MLM—2709(OP))
Mohnen, V.A., SO_2 oxidation rate on well-characterized surfaces, a laboratory study. Final report 15 May 1978-14 May 1979, 5:24619 (PB—301288)
Mokler, P.H., *See* Liesen, D., 5:24827
Molenkamp, C.R., Numerical simulation of self-induced rainout using a dynamic convective cloud model, 5:24635 (UCRL—83583)
Molishever, E., *See* Dao, K., 5:23888
Mollenkopf, H.C., *See* Hopkins, R.H., 5:23809, 5:23810
Monahan, J.E., *See* Holt, R.J., 5:24897
Monahan, K.M., *See* Jonath, A.D., 5:23807
Monarch, M.R., *See* Cirillo, R.R., 5:23850
Monsay, E., *See* Gottschalk, T., 5:24884
Montbriand, R., *See* O'Connor, K., 5:23605
Montgomery, D.R., *See* Lambright, T.M., 5:23702
Montgomery, M.D., Relativistic electron beam plasma heating experiment, 5:24978 (LA—8226-MS)
Montgomery, M.E., Treating and feeding SRC to demonstrate its suitability as a gas turbine fuel. Phase II. Final report, 5:23562 (FE—2304-43)
Monticello, D.A., *See* Bhattacharjee, A., 5:25017
Moore, C.B., *See* Hess, P., 5:24822
Moore, C.E., *See* Kanabrocki, E.L., 5:24484
Moore, R.E., HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)
Moore, R.L., *See* El-Genk, M.S., 5:24088
Moore, T.S., *See* Skinner, Q.D., 5:23664
Mooz, W.E., *See* Stucker, J.P., 5:24263
Moran, M.S., Impacts of deep geothermal fluid production on shallow groundwater systems, 5:23983 (CONF-7910155—1)
Morgan, C.J., *See* Fryer, A.J., 5:24129
Morgan, M.E., Inorganic constituents in American lignites, 5:23456 (FE—2030-TR21)
Morley, D., $Li/SOCl_2$ cell as an effective power source, 5:24149
Morrall, J., Improving the intercity bus through transportation systems management, 5:24288
Morris, C.L., *See* Kaellne, J., 5:24889
Morris, J.S., Determination of ^{226}Ra, ^{214}Pb, and ^{214}Bi in fly ash samples from eighteen (18) coal fired power plants in the United States, 5:23457 (METC/SP—79/10(Pt.1), pp 460-470)
Morris, J.W. Jr., Point-obstacle representation of the dislocation-obstacle interaction, 5:24383
See Hong, M., 5:24515
See Mahin, K.W., 5:24376
Morrison, R.E., *See* Kinder, D.L., 5:23497
Morrissey, D.J., Target residues from the reaction of 8 GeV ^{20}Ne with ^{181}Ta and ^{197}Au, 5:24926
Morrissey, S.P., *See* Bionta, R.M., 5:24852
Morse, J.G., Nuclear technology developments affecting uranium needs, 5:23672
Uranium resource/technology update: front end of the nuclear fuel cycle, 5:23711
Morse, L.E., *See* Till, J.E., 5:23704
Morse, W.M., Search for the violation of time-reversal invariance in K°/sub mu3/ decays, 5:24847
Mortensen, M.H., W(p,t) reactions. I. Even targets, 5:24924
W(p,t) reactions. II. Odd target, 5:24925
Mosel, U., *See* Kunz, J., 5:24920
Moses, G.A., *See* Ragheb, M.M.H., 5:25083
Moses, J.D., *See* Cindro, N., 5:24909
Moses, R.G., *See* Ford, C.T., 5:23540
Mosher, D., *See* Ottinger, P.F., 5:25081
Moss, G., Burner equipment and operation thereof, 5:24506
Utilization of solid material containing combustible matter, 5:23563
Motley, R.W., Vortex formation during rf heating of plasma, 5:24980 (PPPL—1658)
Motowidlo, L., Influence of dislocation drag on twinning in zinc, 5:24403
Moudy, L.A., *See* Manasevit, H.M., 5:23804
See Ruth, R.P., 5:23808
Mozer, F.S., Average parallel electric field deduced from the latitude and altitude variations of the perpendicular electric field below 8000 kilometers, 5:24803
Mrazek, R.V., *See* Fitzgerald, T.J., 5:23560
Mubayi, V., Framework for energy policy and technology assessment in developing countries: a case study of Peru, 5:24200 (BNL—27613)
Mueller, R., *See* Asbury, J., 5:24243
Mukamel, S., *See* Hopkins, J.B., 5:24812
Mukherjee, S.K., Status of the fertilizer industry in India, 5:23789
Mullaney, D.H., *See* Fleming, R.B., 5:24534
Mullendore, A.W., Development and laboratory testing of low Z refractory coatings for fusion reactor limiters, 5:25093 (SAND—79-2409C)
See Langley, R.A., 5:25088
See Whitely, J.B., 5:25092
Muller, R.H., *See* Hauge, P.S., 5:24971
Muller, R.N., *See* Alberts, J.J., 5:24655
Mullins, J., *See* Kenik, E.A., 5:24394
Mumma, S.A., Innovative double walled heat exchanger for use in solar water heating, 5:23944
Munn, R.L., *See* Ashby, J.B., 5:23486
Munro, J.K. Jr., HLYWD: a program for post-processing data files to generate selected plots or time-lapse graphics, 5:25015 (ORNL/CSD/TM—109)
Munshower, F.F., Metals in soft tissues of mule deer and antelope, 5:24775
Munson, D.E., Evaluation of European empirical methods for subsidence in US coal fields, 5:23538 (SAND—80-0537)
Murakami, M., *See* Gilgenbach, R.M., 5:24988
Murnick, D.E., *See* Pappas, P.G., 5:24813
Murphy, J.M. Jr, *See* Roth, M., 5:24317
Murphy, L.J. Jr, *See* Merrick, E.T., 5:24621
Murray, J.E., *See* Lowdermilk, W.H., 5:24526
Murtha, M.J., New developments in the lime-soda sinter process for recovery of alumina from fly ash, 5:23466 (METC/SP—79/10(Pt.1), pp 68-84)
See Roy, N.K., 5:23542
Myers, D.J., *See* Johnson, E.L., 5:23830
Myers, S.M., Properties and applications of ion-implanted alloys, 5:24410

N

Nachtsheim, C.J., Modeling the number of bids received on federal offshore hydrocarbon leases by poisson-type models, 5:23601 (LA—8347-MS)
Nagel, D.J., *See* Ripin, B.H., 5:25082
Nagelberg, A.S., Corrosion behavior of lean uranium-titanium alloys, 5:24414 (SAND—80-8215)
See Farrow, R.L., 5:24464
Nagy, A., *See* Reid, R.L., 5:25044
Najmi, A., *See* Flint, B.K., 5:24521
Nakanishi, H., *See* Kawabe, N., 5:23606
Namboodri, C.G., Application of foams to the processing of fabrics. Phase-III. Technical progress report, September 1, 1979-February 29, 1980, 5:24299 (DOE/CS/40056—T1)
Nance, W.B., *See* Elrod, S.H., 5:23580
Napier, A., *See* Brick, D., 5:24854
Napier, B.A., PABLM: a computer program to calculate accumulated radiation doses from radionuclides in the environment, 5:24754 (PNL—3209)
Narang, K.C., *See* Chopra, S.K., 5:23492
Narasimha Rao, B.V., Structure-property relations and the design of Fe-4Cr-C base structural steels for high strength and toughness, 5:24378
Narayan, J., Formation of Ohmic contacts in semiconducting oxides, 5:24431
Structural defects in laser- and electron-beam annealed silicon, 5:24374 (CONF-791112—62)
Narukawa, S., *See* Ikeda, H., 5:24145
Nasise, J.E., Performance and improvements of the tritium handling facility at the Los Alamos Scientific Laboratory, 5:23721 (LA-UR—80-1265)
Natusch, D.F.S., *See* Skogerboe, R.K., 5:23666
Nave, S.E., Micromagnetic susceptometer, 5:24578
Navok, T., *See* Chevion, M., 5:24670
Neal, C.L., Residential passive solar energy design competition for North Carolina. Final report, November 1, 1978-April 9, 1979, 5:23889 (NCEI—0013)
Neamatalla, M., *See* Schultz, H.W., 5:24327
Nebgen, J.W., Utilization of ash and scrubber sludge in agriculture: a systems study, 5:23506 (METC/SP—79/10(Pt.2), pp 873-884)
Neeper, D.A., Active solar collector and materials research, 5:23952 (LA-UR—80-852)

Nelson, C.A., *See* Berg, D., 5:24841
Nelson, D.M., *See* Kanabrocki, E.L., 5:24484
Nelson, E.T., *See* Ahn, Y.K., 5:23835
Nelson, M.E., *See* Himel, T.M., 5:24840
Nemethy, P., *See* Sandweiss, J., 5:24851
Nesbit, W., Going with the wind, 5:24002
Neta, P., *See* Kumar, A., 5:24502
Neton, J., Cross-placental transfer of ^{243}Cm in the baboon, 5:24759 (COO—3382-18, pp V.1-V.6)
Short term kinetics of uranium in the adult baboon: preliminary data, 5:24760 (COO—3382-18, pp VI.1-VI.7)
See Cohen, N., 5:24758
Neuendorf, D.W., *See* Tolle, D.A., 5:24652
Neufeld, R.D., Environmentally acceptable disposal of coal conversion solid waste residuals. Progress report, April 21, 1979-July 31, 1979, 5:23458 (DOE/PC/20023—1)
Neuman, D.R., *See* Munshower, F.F., 5:24775
Newby, R.A., *See* O'Neill, E.P., 5:24032
Newkirk, L.R., *See* Behrens, R.G., 5:24395
Newman, M.J., *See* Winkler, K.A., 5:24794
Newsom, D.E., Preliminary comparative assessment of land use for the satellite power system (SPS) and alternative electric energy technologies, 5:23848 (DOE/ER—0054)
Ney, R.J., Quartz crystal fabrication facility. Phase I. Final report, April 1977-September 1979, 5:24537 (GEPP-FR—434)
Ng, K.K., Asymmetry in the SiO_2 tunneling barriers to electrons and holes, 5:24473
Ng, S.Y., Experience with geotechnical methods for design of flyash embankments and structural fills, 5:23498 (METC/SP—79/10(Pt.2), pp 725-747)
Ng, Y.C., *See* Bonner, N.A., 5:24654
Nicarico, T.J., *See* Stevens, R.D., 5:24343
Nichols, A.V., *See* Forte, T.M., 5:24718
Nichols, D.E., *See* Waitzman, D.A., 5:23787
Nichols, R.J., *See* Donnelly, J.J. Jr., 5:24340, 5:24341
Nicks, L.J., *See* Baglin, E.G., 5:23774
Nicolescu, L.D., Criterion of estimating the efficiency of fly-ashes in cements and concretes, 5:23491 (METC/SP—79/10(Pt.2), pp 624-630)
Experimental cements with fly ashes, 5:23494 (METC/SP—79/10(Pt.2), pp 659-678)
Nicolet, M., *See* Masuyama, A., 5:24479
Niece, J.E., *See* Delwiche, P., 5:23479
Niemeyer, W., Solar production of industrial process hot water, 5:23918 (SERI/TP—333-429, pp 187-191)
Nieves, L., Getting into hot water: the use of reject heat in aquaculture, 5:24310
Nigmatullin, N.P., *See* Gryazev, V.M., 5:24060
Niles, P.W., *See* Carnegie, E.J., 5:23921
Nilson, R.H., *See* Klamerus, L.J., 5:24446
Nitschke, E., *See* Franke, F.H., 5:23433
Nix, C.E., *See* Rao, T.K., 5:24765
Nix, J.R., Superheavy elements, 5:24934
Noble, H.D., Open backflow system, 5:23970
Noetzel, A.S., Generation of approximating distributions through the method of stages, 5:25104 (BNL—27513)
Noll, S.A., Residential solar home resale analysis, 5:23885 (LA-UR—80-1014)
Noomen, A., process for coating a substrate with a radiation and moisture curable coating composition, 5:24503
Noonan, J.R., 1979 LEED analysis of Cu(100), 5:24408
Nordsieck, R.A., *See* Lurman, F., 5:24611
See Lurmann, F., 5:24612
Noren, D.V., Comparison of alternate power sources for the MX missile system, 5:24334
Norris, C.B., Cathodoluminescence studies of anomalous ion implantation defect introduction in ZnTe, 5:24482
Nottenburg, R., *See* DuBow, J., 5:23646
Novotny, M., *See* Schultz, R.V., 5:23453
Nozik, A.J., *See* Boudreaux, D.S., 5:24542
Null, H.R., Process for hydrogen recovery from ammonia purge gases, 5:23777
Nunamaker, T.A., *See* Heisterberg, R.H., 5:24848
Nylinder, M., Conversion factors fuelwood: oil, 5:23837 (SIU-IVI—110)

O

O'Brien, J., *See* Atallah, S., 5:23611
O'Connor, K., Historic and projected oil and gas consumption, 5:23605
O'Connor, T.E., *See* Willard, K.E., 5:24674
O'Keefe, B.J., Politics of energy, 5:24184
O'Neill, E.P., Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 1. Task I report: literature review, basis for selecting calcium-based sorbents. Final report, 5:24032 (EPRI-FP—1307(Vol.1))
See Ulerich, N.H., 5:24033
O'Neill, J.P., *See* Hsie, A.W., 5:24763
O'Reilly, J., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
O'Sullivan, F.K., *See* Smith, D.R., 5:23852
O'Sullivan, G.A., *See* Smith, D.R., 5:23852
Oakes, K.M., Land use siting considerations for hydrothermal energy facilities, 5:23989 (CONF-800517—4)
Obenschain, S.P., *See* Ripin, B.H., 5:25082
Oblow, E.M., *See* Santoro, R.T., 5:25084
Ochs, T.L., Low temperature industrial process heat from non-convecting solar ponds , 5:23957 (SERI/TP—333-429, pp 139-143)
Oden, L.L., Self-disintegrating raney metal alloys, 5:24370
Oester, Y.T., *See* Kanabrocki, E.L., 5:24484
Ogasawara, M., Upper limit to the excited electron-cation recombination lifetimes of trapped electrons in ethanol and 2-methyl-tetrahydrofuran glasses at 4 and 77 K, 5:24501
Ohad, I., Photoreversible absorbance changes in solutions of allophycocyanin purified from Fremyella diplosiphon: temperature dependence and quantum efficiency, 5:24677
Ohshima, T., *See* Berg, D., 5:24841
Okada, J.T., *See* Burke, G.J., 5:24538
Okada, M., Microstructure and magnetic properties of Fe-Cr-Co alloys, 5:24373
Okrent, D., *See* Badham, V.C., 5:25070
See Cave, L., 5:24080
Okuda, A.S., *See* Combs, L.P., 5:24259
Okuda, H., *See* Sato, T., 5:25032
Olander, D.R., Thermal gradient brine inclusion migration in salt study: gas-liquid inclusions, preliminary model, 5:23732 (ONWI—85)
Oliphant, F., *See* Young, F.C., 5:24563
Olmer, C., *See* Paul, M., 5:24904
See Sanders, S.J., 5:24905
Olsen, J.N., Propagation of light ions in a plasma channel, 5:24997
Olson, B.A., Durability testing at 5 atmospheres of advanced catalysts and catalyst supports for gas turbine engine combustors, 5:24338 (DOE/NASA/9416—80/2)
Olson, R.J., *See* Klopatek, J.M., 5:24643
Omerogie, O., *See* Doscher, T., 5:23577
Ono, M., *See* Wong, K.L., 5:25003
Opp, D.A., Special reporter comments and questions, 5:24075 (EPRI-EL—1263, pp 12.1-12.5)
Orcasberro, R., *See* Smith, G.S., 5:24331
Oreglia, M., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Orens, L.O., Active solar space heating utilizing phase change storage, 5:23896
Ortabasi, U., Evacuated tubular collector utilizing a heat pipe. Final report, August 1-September 30, 1977, 5:23950 (COO—2608-3)
Orth, C.J., Nuclear disintegration of some complex nuclei by 60-MeV muons, 5:24899
Products of stopped-pion interactions with Cu and Ta, 5:24914
Ortiz, P., *See* Kast, M., 5:23934
Ortolf, J.M., *See* Johnson, C.H., 5:24992
Osborne, R., *See* Fleet, C., 5:24282
Oset, E., Core polarization effects in inelastic pion-nucleus scattering, 5:24947
Osgerby, I.T., *See* Olson, B.A., 5:24338
Ott, E., Theory of electron cyclotron resonance heating of tokamak plasmas, 5:24984
Ott, K.O., *See* Maudlin, P.J., 5:24187
Ottesen, D.K., *See* Nagelberg, A.S., 5:24414
Ottinger, P.F., Propagation of intense ion beams in straight and tapered z-discharge plasma channels, 5:25081
Otts, J., Solar total energy project at the Sandia Laboratories Midtemperature Solar Systems Test Facility (MSSTF), 5:23861 (SERI/TP—333-429, pp 145-149)
Ou, T.C., *See* Brick, D., 5:24854
Overton, D.E., Effects of contour coal strip mining on stormwater runoff and quality, 5:23518 (ORO—4946-T1)
Owais, M., *See* Baumann, N.P., 5:24936
Owen, M.L., *See* Micheletti, W.C., 5:24007
Owens, B.B., *See* Warburton, D.L., 5:24130
Owoc, H.J., DOE/PETC 5MW two-stage MHD pressurized coal combustor. Quarterly activity report, January 1-March 31, 1980, 5:24217 (COO—4049-16)
Ozarski, R.G., Polarizer reflectivity variations, 5:25076 (UCID—18588)

P

Paar, V., *See* Meyer, R.A., 5:24913
Pachowski, J., The application of brown coal fly ash to road base courses. Final report, 5:24318 (PB—300879)
Page, G.C., *See* Gibson, E.D., 5:23531
Pagezy, M.J., Oil-production platform and method of assembling and installing the same on a sea bed, 5:23581
Painter, R.B., *See* Mattern, M.R., 5:24691, 5:24700
Palmedo, P.F., *See* Mubayi, V., 5:24200
Pan, G., *See* Gunderson, J., 5:24352
Pang, C.Y., *See* Himel, T.M., 5:24840
Panitz, J.A., Video recording of low intensity CEMA images, 5:24540
Panitz, J.K.G., Low-energy ion erosion studies of machine faceted stainless steel, 5:24416
Pantell, R.H., Inverse synchrotron interaction, 5:25041
Papanicolas, C.N., *See* Lichtenstadt, J., 5:24931
Pappas, J.M., *See* Adt, R.R. Jr., 5:24357
Pappas, P.G., Saturation spectroscopy with laser optical pumping in atomic barium, 5:24813

Paras, P., *See* Hine, G.J., 5:24562
Paretzke, H.G., *See* Wilson, W.E., 5:24722
Parish, T.A., Reduction in the toxicity of fission product wastes through transmutation with deuterium-tritium fusion neutrons, 5:25071
Park, J.Y., Portable probe to measure sensitization of stainless steel, 5:24417
Park, S.D., *See* Cleaver, J.E., 5:24743
Parker, D.G., *See* Thornton, S.I., 5:23499
Parker, J., *See* Taylor, D., 5:24023
Parker, J.C., Water development in Wyoming: a study of resident attitudes, 1971. Completion report, 5:24657 (PB—300495)
Parker, J.V., *See* Montgomery, M.D., 5:24978
Parks, J.E., *See* Petrakian, J.P., 5:24398
Parnell, D.C., Claus UCAP (integrated UCAP) sulfur recovery, 5:23436
Parrott, J.R. Sr., *See* Armento, W.J., 5:23759
Parry, A.A., *See* Radcliffe, S.J., 5:24391
Partridge, L.J., *See* Engelbrecht, A.D., 5:23790
Partridge, R., Decay $J/\pi \rightarrow 3\gamma$ and a search for the eta/sub c/, 5:24842
See Peck, C.W., 5:24838
Parvin, G., *See* Hertzmark, D., 5:23776
Paschmann, G., *See* Gosling, J.T., 5:24798
Paskin, A., Computer simulation of crack propagation, 5:24964
Patil, S.A., *See* Uppuluri, V.R.R., 5:23572
Patrick, J.F., *See* Himel, T.M., 5:24840
Pattas, E., *See* Franke, F.H., 5:23433
Patton, H.G., *See* Stowers, I.F., 5:24517
Paul, M., $^{24}Mg(^{16}O,^{12}C)^{28}Si$ and $^{24}Mg(^{16}O,^{16}O)^{24}Mg$ reactions at backward angles, 5:24904
See Sanders, S.J., 5:24905
Pauletta, G., *See* Adams, G.S., 5:24911
Paull, P.L., Partial oxidation process, 5:23772
Paulson, D.L., Method of agglomerating fine powders, 5:23514
Paulson, J.W., Latex bonded lead dioxide reserve electrode, 5:24162
Paulsson, B.N.P., Between-hole acoustic surveying and monitoring of a granitic rock mass, 5:23731 (LBL—10483)
Pavlovich, R.D., Accelerated sulfate testing of mortars containing fly ash as a partial replacement for portland cement, 5:23487 (METC/SP—79/10(Pt.2), pp 544-563)
Pawloski, G., *See* Howard, N.W., 5:24782
Pearce, J.W., Calorimeter for pulsed energy sources, 5:25086 (CONF-791102—165)
Pearce, L., *See* Birt, D., 5:24125
Pearson, J., *See* Fox, R.A. J540, 5:24781
Peaslee, A.T. Jr., *See* Ribe, F.L., 5:25078
Pechan, E.H., *See* Meyers, C.D., 5:24027
Peck, C., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Peck, C.W., Recent results from the crystal ball detector at SPEAR, 5:24838
Pegg, D.J., *See* Gardner, L.D., 5:24824
Pei, Y.K., Draining of the SUNPAK/sup TM/ evacuated tubular collector, 5:23949 (ALO—4150-12)
Peil, C.A., Fracturing of the Antrim of Michigan, 5:23622
See McNamara, P.H., 5:23634
Peker, L.K., Is there evidence for rotation along the axis of symmetry in transitional nuclei, 5:24919
See Gilat, J., 5:24935
Peled, E., Passivating layer on lithium in lithium tetrachloroaluminate-$SOCl_2$ solutions, 5:24170
Pellet, R.J., *See* Kim, D.K., 5:23438
Pelte, D., *See* Stokstad, R.G., 5:24916
Penello, W.F., *See* Vaughn, J.M., 5:24731
Perkins, P., *See* Carey, D., 5:23534
Perl, M.L., *See* Himel, T.M., 5:24840
Perlman, M.L., *See* Krinsky, S., 5:24557
Perry, D.G., *See* Wilcke, W.W., 5:24937
Perry, D.J., *See* Holt, J.G., 5:24954
Perry, E., *See* Null, H.R., 5:23777
Perry, H., Future availability of feedstocks for ammonia production, 5:23781
Perry, J., Fuel cell anode electrode, method of making the fuel cell anode electrode, and fuel cell containing the fuel cell anode electrode, 5:24240
Pery, G., *See* Cave, L., 5:24080
Pestov, Yu.N., *See* Laptev, V.D., 5:24564
Pesut, R.N., *See* Howes, J.E. Jr, 5:24608
Peter Gary, S., *See* Simons, D.J., 5:24802
Peterie, T.J., *See* Grau, B., 5:24644
Peters, E.T., Evaluation of stationary source particulate measurement methods. Volume III. Gas temperature control during method 5 sampling. Interim report oct 73-February 1977, 5:24607 (PB—300336)
Peters, J.A., *See* Wang, P.S., 5:24437
Petersen, D., *See* Brick, D., 5:24854
Peterson, D.T., *See* Rosei, R., 5:24401
Peterson, E., *See* Berg, D., 5:24841
Peterson, R.S., *See* Gardner, L.D., 5:24824
Peterson, R.W., Geotechnical properties of a fine-grained spent shale waste, 5:23645
Petrakian, J.P., Optical properties of liquid tin between 0.62 and 3.7 eV, 5:24398
Petrasso, R., Soft x-ray imaging instrument for the Alcator A tokamak, 5:24999
Petrovykh, N.V., *See* Laptev, V.D., 5:24564
Pevsner, A., *See* Brick, D., 5:24854
Pfeiffer, W., *See* Waltz, R.E., 5:25040
Phaup, C.W., Subfloor for offshore production platform, 5:23585
Phelps, P.L. Jr., *See* Stephens, F.B., 5:23993
Phillips, C., *See* Parker, J.C., 5:24657
Phillips, J.F. Jr., *See* McCullough, J.F., 5:23700
Phillips, S.L., Computerized international geothermal information systems, 5:23979 (LBL—10615)
Phillips, T.E., *See* Farrier, D.S., 5:23667
Phillips, W.R., *See* Franey, M.A., 5:24933
Philpot, J.A., Future ammonia business: market and economic considerations, 5:23791
Phipps, E.L., *See* Russel, W.L., 5:24774
Pickering, H.W., *See* Sakurai, T., 5:24386
Pickett, D.F., *See* Harkness, J.D., 5:24134
Pickus, M.R., *See* Wang, J.L.F., 5:24362
Picraux, S.T., *See* Wampler, W.R., 5:25004
Pieper, S.C., *See* Rhoades-Brown, M., 5:24943, 5:24944
Pierce, R.D., Advanced fuel cell development. Progress report, April-June 1979, 5:24232 (ANL—79-84)
Advanced fuel cell development. Progress report, July-September 1979, 5:24233 (ANL—79-110)
Pierre, W.F., *See* Glasl, F.G., 5:23869
Pihlaja, R.K., *See* Cole, J.L., 5:23626
Pindyck, R.S., International comparisons of the residential demand for energy, 5:24258
Pistilli, M.F., *See* Bobrowski, G.S., 5:23485
Pitts, J.N. Jr, Detailed characterization of gaseous and size-resolved particulate pollutants at a south coast air basin smog receptor site: levels and modes of formation of sulfate, nitrate and organic particulates and their implications for control strategies. Final report November 1975-June 1978, 5:24620 (PB—301294)
Pivec, A., *See* Lewis, P.A., 5:24163
Place, W., Human comfort and auxiliary control considerations in passive solar structures, 5:23886 (LBL—10034)
Plahutnik, F., *See* McCormick, J.R., 5:23815
Plano, R.J., *See* Brick, D., 5:24854
Platts, D.A., *See* Jarboe, T.R., 5:25049
Pless, I.A., *See* Brick, D., 5:24854
Ploeger, W.M., *See* Campbell, E.M., 5:23761
Ploetz, G., *See* Goeddel, D.L., 5:24344
Plummer, E.W., *See* Levinson, H.J., 5:24409
Podolski, W.F., *See* Johnson, I., 5:23558
Poeppel, R.B., *See* Pierce, R.D., 5:24232, 5:24233
Poggio, E.C., Addendum to "Hadronic corrections to the annihilation rateof heavy vector mesons to lepton pairs", 5:24865
Pohl, D.R., *See* Blakey, B.H., 5:23963
Pohlman, S., *See* Webb, J., 5:23860
Poirier, D.J., *See* Aigner, D.J., 5:24197
Polednak, A.P., Long-term effects of radium exposure in female dial workers: liver function and liver disease, 5:24778
Pollock, J.M. Jr., *See* Jackson, J.B., 5:24683
Pomerantsev, G.B., *See* Bakumenko, O.D., 5:24061
Pomraning, G.C., *See* Badham, V.C., 5:25070
Pomroy, S.E.A., *See* Doran, R.J., 5:24172
Pongratz, M.B., *See* Simons, D.J., 5:24802
Ponte, N.S., *See* Menon, M.M., 5:25063
See Wright, R.E., 5:25052
Porkolab, M., Rf heating of mirrors, 5:24982 (UCID—18623)
Porter, F., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Posner, D., Photovoltaic procurement strategies: an assessment of supply issues, 5:23853 (SERI/TR—352-298)
Post, R.F., Some implications for mirror research of the coupling between fusion economics and fusion physics, 5:25045 (UCRL—84245)
Post, S.F., *See* Cox, L.E., 5:24348
Potokar, M., *See* Roberson, N.R., 5:24912
Potter, D.W., Impulsive 2—10 keV solar electron events not associated with flares, 5:24797
Potter, G.D., Offsite environmental monitoring report for the Nevada Test Site and other test areas used for underground nuclear detonations, January-December 1979, 5:24630 (EMSL-LV—0539-36)
Poukey, J.W., *See* Humphries, S. Jr., 5:24550
Poulson, R.E., *See* Farrier, D.S., 5:23667
Pound, J., Economic and environmental aspects of a new coal ash recycling/disposal process, 5:23481 (METC/SP—79/10(Pt.1), pp 448-459)
Pouska, G.A., *See* Link, J.M., 5:23644
Powell, D., *See* Sierer, P.D. Jr., 5:23924
Powell, J.B., *See* Hanna, W.W., 5:24715
Powers, D., *See* Reilinger, R., 5:24786
Powers, D.E., *See* Hopkins, J.B., 5:24812
Prael, R.E., *See* Das, S.G., 5:24952
Pratt, J.C., *See* Highland, V.L., 5:24843
Pratt, W.T., *See* Gasser, R.D., 5:24098
Press, K.K., *See* Dand, P.V., 5:24107
Principe, P.P., *See* Cohen, J.B., 5:24626
Prior, J., *See* Ozarski, R.G., 5:25076
Prior, M., *See* Eriksson, S., 5:23515
Prosser, F.W. Jr., Complete fusion of $^{15}N + ^{27}Al$, 5:24906
Pryde, P.R., Geothermal energy development in the Soviet Union, 5:23982
Puglisi, V.J., Sealed nickel cadmium cell design by computer modeling, 5:24111
Pugsley, M., Nevada geothermal commercialization planning. Quarterly progress report, January 1, 1980-March 31, 1980, 5:23980 (DOE/RA/50076—T1)
Putney, Z., *See* Lindmayer, J., 5:23855
Puzak, J.C., *See* Fair, D.H., 5:24610

Q

Qualheim, B.J., *See* Howard, N.W., 5:24782
Quinby, T.C., High-temperature, high-pressure bonding of nested tubular metallic components, 5:24568
Quintenz, J.P., *See* Burns, E.J.T., 5:24481

R

Rabenhorst, D.W., Low-cost flywheel demonstration program. Final report, 1 October 1977-31 December 1979, 5:24099 (CONS—5085-T2)
Rabinowitz, M., *See* Jakovcic, S., 5:24684
Rabl, V., *See* Asbury, J., 5:24243
Racca, R.A., *See* Prosser, F.W. Jr., 5:24906
Racine, D., High frequency seismic signals at five United States observatories. Final report, 5:24784 (UCRL—15220)
Seismicity of the salt areas of Texas, Louisiana, Oklahoma and Kansas, 5:24785 (UCRL—15221)
Rack, H.J., Postmortem metallurgical examination of a fire-exposed spent fuel shipping cask, 5:24519 (SAND—79-1424)
Radcliffe, K.S., Bureau of Mines oil shale data bank, 5:23617
Radcliffe, S.J., Dispersion of life of bonded MoS2 solid lubricant coatings, 5:24391
Rafferty, C.N., Photooxidation of antenna bacteriochlorophyll in chromatophores from carotenoidless mutant Rhodopseudomonas sphaeroides and the attendant loss of dimeric exciton interaction, 5:24682
Ragaini, R.C., *See* Meyer, R.A., 5:24913
Ragheb, M.M.H., Pellet ad pellet-blanket neutronics and photonics for electron beam fusion, 5:25083
Rai-Choudhury, P., *See* Hopkins, R.H., 5:23809, 5:23810
Raider, S.I., *See* Voss, R.F., 5:24516
Raines, G.E., *See* Lemmon, A.W. Jr, 5:23526, 5:23527
Rajeshwar, K., *See* DuBow, J., 5:23646
Raju, P.P., *See* Tsacoyeanes, J.C., 5:24042
Raley, J.H., Evaluation of retort performance from gas data, 5:23633
See Ackerman, F.J., 5:23639
Ramakrishnan, J., Anomalous behavior of the Grueneisen parameter in cerium near the high-pressure phase transition, 5:24396
Rammey-Smith, A., An investigation of preferences for various types of energy cost feedback. Final report, 5:24212 (PB—300314)
Ramos, J.J., *See* Coppi, B., 5:24986
Ramsey, A., *See* Petrasso, R., 5:24999
Ramsey, G.H., *See* VanOsdell, D.W., 5:24031
Randrup, J., One-body dissipation and nuclear dynamics, 5:24948
Rao, C., *See* Cox, D., 5:24308
Rao, T.K., Mutagenicity testing of aqueous materials from alternate fuel production, 5:24765 (CONF-790663—3)
Rapaport, J., *See* Finlay, R.W., 5:24915
Rapp, C.F., Solar collector structures containing thin film polysiloxane, and solar cells, 5:23829
Raskin, D., Energy storage propulsion system for rapid transit cars. Test results and system evaluation. Final report, 5:24347 (PB—300918)
Rasolt, M., Wave-vector decomposition of the exchange and correlation contributions to a metallic surface energy, 5:24967
See De, G.S., 5:24959
Rasson, J., *See* Dao, K., 5:23888
Rauch, H.W., *See* Fedarko, W., 5:23413
Ray, D., *See* Hertzmark, D., 5:23776
Ray, E.E., *See* Smith, G.S., 5:24331
Raymer, G.D., *See* Russell, L.B., 5:24750
Raymond, J.R., *See* Brandstetter, A., 5:23737
Razdow, A.M., Thermal desorption measurements of hydrogen—isotope retention in the Alcator-A tokamak, 5:25101
Read, M.E., *See* Gilgenbach, R.M., 5:24988
Reader, J., *See* Burkhalter, P.G., 5:25002
Reay, N.W., Measurement of charmed particle lifetimes, 5:24845
Rebert, C., *See* Doscher, T., 5:23577
Reedy, R.C., Silver isotopic anomalies in iron meteorites: cosmic-ray production and other possible sources, 5:24801 (LA-UR—80-1199)
Regan, J.D., *See* Dunn, W.C., 5:24688
Rehm, K.E., *See* Prosser, F.W. Jr., 5:24906
Reichman, J., *See* Chen, S., 5:23845
Reichman, J.M., Research and development of a high-pressure waterjet coring device for geothermal exploration and drilling. Final report, February 1976-October 1977, 5:23997 (RLO—2325)
Reid, R.L., Evaluation of the impact of a committed site on fusion reactor development, 5:25044 (CONF-791102—163)
Reier, M., Reactivity monitoring. Final report, Task 2, 5:23706 (DOE/ET/47906—4)
Reierson, J.D., *See* Mendis, M.S., 5:23537
Reilinger, R., New evidence for tectonic uplift in the Diablo Plateau region, West Texas, 5:24786
Reilly, L.J., Examination of implementation strategies for the Building Energy Performance Standards, 5:24255 (DOE/PE/70106—T1)
Reimann, J., *See* Solbrig, C.W., 5:24081
Reinovsky, R.E., *See* Henderson, R.P., 5:25060
Renken, R.L., *See* Richards, P.M., 5:24472
Rescigno, T.N., *See* McCurdy, C.W., 5:24829
Reynen, T.A., *See* Sanders, D.B., 5:24283
Reynolds, G.L., Grain-boundary diffusion in uranium dioxide: the correlation between sintering and creep and a reinterpretation of creep mechanism, 5:24432
Rheinboldt, W.C., *See* Babuska, I., 5:25115
Rhoades-Brown, M., Techniques for heavy-ion coupled-channels calculations. I. Long-range Coulomb coupling, 5:24943
Techniques for heavy-ion coupled-channels calculations. II. Iterative solution of the coupled radial equations, 5:24944
Rhodes, R.C., *See* Fair, D.H., 5:24610
Ribe, F.L., Evaluation of impact fusion concepts. Final report, 1 June 1979-1 December 1979, 5:25078 (UWFPP—7)
Production of substitute natural gas by a fusion hybrid reactor coupled to a catalyzed coal gasification plant. Final report, 1 May 1979-1 October 1979, 5:23766 (UWFPP—6)
Rice, M., Analysis of PURPA and solar energy, 5:23799 (SERI/TR—434-484)
Richards, P.M., Computer-simulated hopping in a random one-dimensional system, 5:24472
Richardson, J.L., *See* Blankenbecler, R., 5:24878
Richardson, M., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Richman, C., High LET dose measurements in patients undergoing pion radiotherapy, 5:24725
Richter, B., *See* Himel, T.M., 5:24840
Ricketts, W., *See* Kincannon, D.F., 5:24313
Ridley, R.D., Progress in Occidental's shale oil activities, 5:23637
Rieber, M., Comparative costing and capacity measurements: methodological considerations, 5:23551
Riedinger, L.L., *See* Yates, S.W., 5:24922
Riedl, F.J., Upgrading of coal liquids: hydrocracking of EDS process derived gas oils. Interim report, 5:23447 (FE—2566-33)
Rigby, F., *See* Witkin, R., 5:23981
Rigby, J.G., *See* Tucker, G.B., 5:23739
Rijken, T., *See* Marker, D., 5:24871
Rijken, T.A., New optimal polynomial theory for NN-scattering, 5:24844 (DOE/ER/10516—T2)
Riley, R.E., Method for making hot-pressed fiber-reinforced carbide-graphite composite, 5:24455
Rill, R.L., *See* Jackson, J.B., 5:24683
Ripin, B.H., Laser-plasma interaction and ablative acceleration of thin foils at 10^{12}—10^{15} W/cm^2, 5:25082
Properties of ablatively accelerated targets, 5:25074 (NRL-MR—4212)
Ritch, G.P., Analyzing the FREQ3CP freeway operations simulation model. Research report, 5:24276 (PB—301117)
Ritterman, P.F., Long life lightweight nickel-cadmium battery development, 5:24110
Riva, L.A., *See* Harris, H.E., 5:23523
Robb, W.A., *See* Smith, J.W., 5:23635
Roberson, N.R., Evidence for an E2 resonance observed by radiative capture of fast neutrons by ^{40}Ca, 5:24912
Roberts, W.O., Consequences of a hypothetical world climate change produced by increased atmospheric carbon dioxide. Progress report, 1 September 1979-31 April 1980, 5:24591 (DOE/EV/10281—1)
Robertson, D., *See* Brick, D., 5:24854
Robertson, D.E., Activation analysis, 5:24485
Robins, J.D., Environmental assessment of surface mining methods: head-of-hollow fill and mountaintop removal. Interim report November 1975-January 1977, 5:23525 (PB—300540)
Robinson, E.L., *See* Yates, S.W., 5:24922
Robinson, G.L., *See* Lemmon, A.W. Jr, 5:23526, 5:23527
Robinson, P.R., *See* Bamberger, C.E., 5:23769
Rock, E.B., *See* Strongin, M., 5:24367
Rodriguez-Anza, J.M., *See* Mumma, S.A., 5:23944
Rodrique, G.H., Odd-even reduction for banded linear equations, 5:25114
Rogan, J.E., *See* Sommerlad, R.E., 5:23917
Rogers, .E., *See* Lemmon, A.W. Jr, 5:23527
Rogers, H.H., Design of long life nickel hydrogen cells, 5:24112
Rogers, S.E., *See* Lemmon, A.W. Jr, 5:23526
Rohatgi, A., *See* Hopkins, R.H., 5:23809, 5:23810
Rohr, D., *See* Springer, R.W., 5:24380
Romero, R., Environmental sampling program for a solar evaporation pond for liquid radioactive wastes, 5:23729 (LA—8177)
Ronis, D., Unified model of the smectic-A, nematic, and isotropic phases for bulk, interfaces, and thin films: Bulk, 5:24956
Ronningen, R.M., *See* Yates, S.W., 5:24922
Rony, P.R., *See* Squires, A.M., 5:23448
Roof, R.B., High-pressure phase in americium metal, 5:24377
Rose, A.B., *See* Blue, J.L., 5:24244
Rose, B.H., *See* Klaffky, R.W., 5:24438

Rose, J.G., Composition and properties of Kentucky power plant ash, 5:24035 (METC/SP—79/10(Pt.1), pp 220-244)
Rose, M.E., Numerical methods for a general class of porous medium equations, 5:24974 (ANL—80-39)
Rose, R.R., *See* Jacobs, D.G., 5:23733
Rosei, R., Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
Rosell, F.E. Jr., Recent terrestrial and undersea applications of radioisotope thermoelectric generators, 5:23767
Roseman, D.P., Alternative modes of ocean transportation of coal, 5:23548
Rosenberg, J.I., Manpower for the coal mining industry: an assessment of adequacy through the year 2000. Volume I. Executive summary. Final technical report, 5:23536 (FE—3134-1)
See Mendis, M.S., 5:23537
Rosenblatt, C., *See* Ronis, D., 5:24956
Rosencwaig, A., High-resolution photoacoustic thermal-wave microscopy, 5:24577
Rosenthal, A.L., *See* Lacks, S.A., 5:24675
Rosey, R., *See* Hill, F.E., 5:24136
Roslyakov, G.V., *See* Bel'chenko, Yu.I., 5:24549
Rosner, J.C., *See* Pavlovich, R.D., 5:23487
Rosner, J.L., Heavy quarks and new particles, 5:24868
Ross, M., Extension of liquid-metal theory to dense partially ionized plasmas, 5:24834
Ross, W.A., Materials Characterization Center workshop on leaching of radioactive waste forms. Summary report, 5:23738 (PNL—3318)
Rosselet, L., *See* Sandweiss, J., 5:24851
Rossi, H.H., *See* Miller, R.C., 5:24740
Rossnagel, S.M., *See* Dylla, H.F., 5:25097
See Staib, P., 5:25098
See Wampler, W.R., 5:25004
Rost, D.F., Solar collector and industrial heat pump system for process hot water for an aluminum anodizing line, 5:23936 (SERI/TP—333-429, pp 343-354)
Roth, M., Evaluation of the ultraviolet-ozone and ultraviolet-oxidant treatment of pink water. Final report 6 June 1976-30 December 1977, 5:24317 (PB—300763)
Rothmeyer, M.K., *See* Bryant, H.C., 5:23945
Rothwarf, A., An analysis of the influence of cell parameters and the spectral content of incident light on the performance of Cu2S-CdS solar cells. Technical report, 5:23819 (PB—301050)
Rouby, E., *See* Mohiuddin, M., 5:24746
Roussarie, A., *See* Himel, T.M., 5:24840
Routson, R.C., Review of the environmental impact of ground disposal of oil shale wastes, 5:24645
Sorption studies at Hanford for the control of radioactive wastes, 5:23740 (RHO-SA—155)
Routt, K.R., Modeling principles applied to the simulation of a joule-heated glass melter, 5:23716 (DP—1540)
Rowcliffe, A.F., Alloys for a liquid metal fast breeder reactor, 5:24372
Roy, N.K., Use of the magnetic fraction of fly ash as a heavy medium material in coal washing, 5:23542 (METC/SP—79/10(Pt.1), pp 140-164)
See Midurski, T.P., 5:24353
Rozelle, J., *See* Kraft, D.C., 5:23496
Rozsnyai, B.F., Probability distribution of ionized fragments following inner-shell-vacancy creation, 5:24996
See Jacobs, V.L., 5:24828
Rubin, A., *See* Jaehne, H., 5:24189
Rubin, C., *See* Brick, D., 5:24854
Rubin, M.N., Demonstrating the noise control of a coal preparation plant. Volume I. Initial installation and treatment evaluation. Open file report (final), 5:23524 (PB—299963)
Ruddick, K., *See* Berg, D., 5:24841
Rudy, C.E., *See* Sullivan, R.F., 5:23446
Russ, J.S., *See* Bionta, R.M., 5:24852
Russak, M.A., *See* Chen, S., 5:23845
Russel, W.L., Specific-locus test shows ethylnitrosourea to be the most potent mutagen in the mouse, 5:24774
Russell, J.H., *See* Oden, L.L., 5:24370
Russell, J.J., *See* Bionta, R.M., 5:24852
Russell, L.B., Analysis of the albino-locus region of the mouse. III. Time of death of prenatal lethals, 5:24750
Russell, L.H., *See* Combs, L.P., 5:24259
Ruth, R.P., Chemical vapor deposition of thin-film polycrystalline Si for low-cost solar cells. First quarterly technical progress report, July 23, 1979-November 2, 1979, 5:23808 (DOE/ET/23045—1)
See Manasevit, H.M., 5:23804
Ryan, D.M., Low temperature thermal battery: the LiAl/NaAlCl$_4$/MoCl$_5$ system, 5:24128
Ryan, P.M., *See* Menon, M.M., 5:25063
See Schwenterly, S.W., 5:25087
Ryan, W.G., *See* Ashby, J.B., 5:23486
Rylander, H.G., *See* Bullion, T.M., 5:25059
See Gully, J.H., 5:25057
See Mayhall, D.J.T., 5:25058

S

Sadana, D.K., *See* Masuyama, A., 5:24479
Sadrozinski, H., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Saffran, M., *See* Guillet, R., 5:24716
Sahlin, H.L., Space-time energy concentration and the design of DT fusion micro-explosions, 5:25077 (UCRL—81919)
Sakurai, T., Hydrogen absorption in metals: a field ion microscopy study. Progress report, June 1, 1979-May 31, 1980, 5:24386 (DOE/ER/10430—1)
Salamon, M.H., Experimental limits on deviations from Z^2 dependence of Cerenkov radiation by heavy ions, 5:24950
Salerno, R.F., *See* Tibbitts, E.E., 5:24413
Salomaa, M.K., *See* DiRienzo, A.C., 5:24929
Salow, G., Fly ash/boiler slag road bases, 5:23501 (METC/SP—79/10(Pt.2), pp 779-783)
Saltmarsh, M.J., Review of the ISX-B experimental program, 5:25007
Salvesen, K.G., *See* Waterland, L.R., 5:24547
Salzman, G.C., *See* Bartholdi, M., 5:24576
Samara, G.A., Elastic relaxation associated with the formation and motion of Schottky defects in ionic crystals, 5:24459
Samarkin, A.A., *See* Bakumenko, O.D., 5:24061
Samsa, M.E., Selection of alternative central-station technologies for the Satellite Power System (SPS) comparative assessment, 5:23846 (DOE-ER—0052)
Samuni, A., Does oxygen enhance the radiation: induced inactivation of penicillinase. Progress report, December 1, 1979-November 30, 1980, 5:24734 (DOE/EV/03221—62)
See Jacobs, G.P., 5:24744
Sanborn, J.B., *See* Gordon, D.M., 5:23758
Sanchez, A., *See* Bengtson, R.D., 5:25043
Sanders, D.B., Characteristics of urban transportation systems: a handbook for transportation planners. Final report, 5:24283 (PB—301319)
Sanders, J.P., National energy problem in perspective, 5:24194 (CONF-7910153—1)
Sanders, S.J., Resonant behavior of the $^{24}Mg(^{16}O,^{12}C)^{28}Si$ reaction, 5:24905
See Paul, M., 5:24904
Sanderson, J.G., *See* Minerbo, G.N., 5:25080
Sandholtz, W.A., *See* Ackerman, F.J., 5:23639
Sandre, A., Technical and economic feasibility of membrane technology. Technical progress report, December 17, 1979-March 16, 1980, 5:23834 (BSDF—39-2Q-80)
Sandweiss, J., Observation of hadronic charm production in a high resolution streamer chamber experiment, 5:24851
Sanford, E., Process of treating bituminous sands conveyor belt with release agent, 5:23641
Sannikov, B.P., *See* Laptev, V.D., 5:24564
Santavicca, D.A., *See* Bracco, F.V., 5:23426
Santen, D.V., *See* Noomen, A., 5:24503
Santhanam, C.J., Characterization of flue gas cleaning (FGC) wastes from coal combustion, 5:23480 (METC/SP—79/10(Pt.1), pp 405-447)
Santoro, R.T., Integral experiments for fusion reactor design: analysis, 5:25084 (CONF-791058—74)
Sanyal, S., Geothermal environmental impact assessment: subsurface environmental assessment for four geothermal systems, 5:23994 (PB—300851)
Sanzenbacher, C.W., *See* Meissner, D.C., 5:23431
Sapp, C.D., Remote sensing of sulfur dioxide effects on vegetation - photometric analysis of aerial photographs, 5:24767 (PB—300460)
Sard, R., *See* Brick, D., 5:24854
Sargent, C.P., *See* Lichtenstadt, J., 5:24931
Sargent, S.L., Overview of solar pond technology, 5:23937 (SERI/TP—333-429, pp 355-371)
Sarracino, J., *See* Highland, V.L., 5:24843
Sasek, R., *See* Jackson, K.L., 5:23990
Sasso, T.L., Curium-243,4 in the tissues of the adult baboon, 5:24757 (COO—3382-18, pp II.1-II.21)
Distribution and retention of ^{243} ^{4}Cm in the adult baboon, 5:24756 (COO—3382-18, pp I.1-I.29)
See Cohen, N., 5:24752, 5:24758
See Neton, J., 5:24759, 5:24760
Sato, T., Ion-acoustic double layers, 5:25032
Sauer, K., *See* Frank, H.A., 5:24678
See Rafferty, C.N., 5:24682
Savignac, N., Environmental problems of the uranium mining and milling industry, 5:23755
Savins, J.G., Oil recovery by waterflooding with thickened surfactant solutions, 5:23583
Savit, R., *See* Kazama, Y., 5:24856
Sawyer, D., *See* McCormick, J.R., 5:23815
Sawyer, J.W. Jr, Contributions to the foundations of supply for energy and transportation: concepts, economics, and technologies, 5:24264 (PB—300541)
See Harrington, W., 5:24037
Saxena, V.K., Impact of gaseous sulfur and aerosols produced by power plants on the CCN budget. Progress report, September 1, 1978-August 31, 1979, 5:24590 (COO—4965-1)
Sayer, S., *See* Goff, F.E., 5:23986
Saylor, T.K., *See* Bayfield, J.E., 5:24826
Scarbrough, J.O., *See* Kroeger, D.M., 5:24404

Schafer, A.S., *See* Hepler, D.I., 5:23648
Schaleger, L., *See* Ergun, S., 5:23836
Scharff-Goldhaber, G., Pseudomagic nuclei, 5:24940
Scharle, W.J., Large oxygen plant economics and reliability, 5:23786
Scharre, D.L., *See* Himel, T.M., 5:24840
Schechter, D.E., *See* Kim, J., 5:24987
See Menon, M.M., 5:25063
Schenley, R.L., *See* Hsie, A.W., 5:24763
Scherrer, V.E., *See* Burton, J.K., 5:25056
Scheuernstuhl, G.J., *See* Zabinski, R.J., 5:24640
Scheule, H.J., Polyolefin/acylated poly(alkyleneamine) two component fuel additive, 5:24358
Schiager, K.J., *See* Berven, B.A., 5:23756
Schier, W., *See* DiRienzo, A.C., 5:24929
Schiesser, W.E., Development of a modular software system for the dynamic simulation of coal conversion plants. Final report, 5:23423 (FE—2338-14)
Schiferl, D., *See* Roof, R.B., 5:24377
Schiffer, J.P., *See* Paul, M., 5:24904
See Sanders, S.J., 5:24905
Schilling, A.H., *See* Brandstetter, A., 5:23737
Schindler, R.H., *See* Himel, T.M., 5:24840
Schivley, W.W., Revegetation study of eastern and western fly ash, 5:23507 (METC/SP—79/10(Pt.2), pp 885-897)
Schlaikjer, C.R., Thionyl chloride electrolytes containing $B_{10}Cl_{10}^{--}$ and $B^{12}Cl_{12}^{--}$, 5:24171
Schlyer, D.J., Study of coal oxidation by charged particle activation analysis, 5:23452 (BNL—27607)
Schmid, A.H., *See* Lear, D.E. Jr, 5:24021
Schmidt, F.J., Amorphous lead dioxide photovoltaic generator, 5:23831
Schmidt, M.P., *See* Morse, W.M., 5:24847
Schmidt-Boecking, H., *See* Liesen, D., 5:24827
Schmieder, R.W., Overlapping pulse technique for imaging space-time-density contours in a gas, 5:24295
Schmitz, K., Alternative scenario for energy policy: analysis, questions, and remarks on Dr. Erhard Eppler's alternative scenario for energy policy, 5:24204 (Juel-Spez—55)
Schnake, L.D., Grain-dust pelleting costs and capital requirements for stationary and portable plants, 5:23793 (PB—300690)
Schneider, J.W., Stress relaxation of cellular silicone material, 5:24445 (BDX—613-2399)
Schnitzer, H.J., *See* Grisaru, M.T., 5:24858
See Poggio, E.C., 5:24865
Schoenfelder, J.L., Passive solar home, 5:23902
Solar greenhouse phase change storage, 5:23974
Using a collector 24 hours a day, 5:23895
Schottler, G.R., Environmental analysis for the Bureau of Mines oil shale research facility, 5:23662
Schreiber, R.E., *See* Johnson, A.B. Jr., 5:23709
Schreyer, H.L., Accurate numerical solutions for elastic-plastic models, 5:24052 (ANL—80-31)
Schriefer, A.H. Jr., Solar panel, 5:23968
Schroeder, N.C., Purification of dihexyl N,N-diethylcarbamylmethylenephosphonate by mercury (II) precipitation, 5:23718 (ENICO—1026)
Schroeder, R.C., *See* Benson, S.M., 5:23999
Schroeder, W.U., *See* Wilcke, W.W., 5:24937
Schuch, R., *See* Liesen, D., 5:24827
Schuhmann, R. Jr, Sulfur fixation during coal gasification. Final report 1 March 1975-28 February 1978, 5:23414 (PB—301104)
Schuler, H.F., *See* Rost, D.F., 5:23936
Schultz, H.L., Treatment categories for coal mine drainage. Final report January 1978-January 1979, 5:24617 (PB—301065)
Schultz, H.W., A pollution-free system for the economic utilization of municipal solid waste for the city of new york. phase i. a critical assessment of advanced technology. I. Thermal oxidation processes. II. Biochemical conversion processes. III. Refuse collection technology. IV. Reclamation and recycling, 5:24327 (PB—300465)
Schultz, R.V., Separation and structure elucidation of coal molecule fragments. Final report, February 1, 1976-August 31, 1979, 5:23453 (DOE/EV/2856—5)
Schulz, H.W., *See* Szostak, R.M., 5:24326
Schulze, W.D., *See* Ives, B.C., 5:24665
Schumacher, P., Vehicle longitudinal control and reliability project. A review of AGT propulsion, power conditioning, braking and power distribution technology. Final report, 5:24346 (PB—300373)
Schwab, C., *See* Hodby, J.W., 5:24468
Schwalbe, L.A., *See* Roof, R.B., 5:24377
Schware, R., Toward a political analysis of the consequences of a world climate change produced by increasing atmospheric carbon dioxide, 5:24664 (CONF-800475—1)
Schwarz, A.C., *See* Lee, L.M., 5:24430
Schwarz, R.I., Primary avian tendon cells in culture: an improved system for understanding malignant transformation, 5:24708
Schweizer, T.C., *See* Cordell, K.R., 5:24900
Schwenterly, S.W., Direct cryosorption pumping of an energetic hydrogen ion beam, 5:25087 (CONF-791102—171)
Schwitters, R.F., *See* Himel, T.M., 5:24840
Schwitzgebel, K., Mechanical strength development and permeability of fly ash-sludge-lime mixtures, 5:23475 (METC/SP—79/10(Pt.1), pp 294-311)
Sckopke, N., *See* Gosling, J.T., 5:24798
Scott, D., Hydrobus, gyrobus use brake-generated energy, 5:24350
Scott, R.B., *See* Wilmoth, R.C., 5:24316
Scriminger, W.F., *See* Kincannon, D.F., 5:24313
Seaborg, G.T., *See* Morrissey, D.J., 5:24926
Seager, C.H., Improvement of polycrystalline silicon solar cells with grain-boundary hydrogenation techniques, 5:23822
Seals, R.K., *See* Head, W.J., 5:23495
Seary, A.J., *See* Ingalls, R., 5:24465
Secco, F., *See* Liaw, M., 5:23816
Seeley, F.G., Recovery of resource materials from coal ash, 5:23470 (METC/SP—79/10(Pt.1), pp 165-192)
See Canon, R.M., 5:23465
Seguin, F.H., *See* Petrasso, R., 5:24999
Seibert, M., Biological solar cell, 5:23844 (SERI/TP—623-656)
Seiger, H.N., Considerations of capacity increases in sintered plate nickel oxide electrodes, 5:24133
Seipenbusch, J., *See* Cornils, B., 5:23437
Sellars, F.M., *See* Midurski, T.P., 5:24353
Sellin, I., Differential charge transfer to the continuum by ions in atomic hydrogen. Progress report and renewal proposal, 5:24819 (DOE/ER/10512—T1)
Sellin, I.A., *See* Gardner, L.D., 5:24824
Semler, J.H., *See* Bracco, F.V., 5:23426
Senew, M.J., *See* Levine, E.P., 5:23849
Sephton, H.H., *See* Glasl, F.G., 5:23869
Sergeev, V.A., *See* Bakumenko, O.D., 5:24061
Serne, R.J., *See* Brandstetter, A., 5:23737
Serot, D.E., Analysis of Federal Government energy emergency programs. Energy policy study, Volume 5. AR/EI-80-05, 5:24195 (DOE/EIA—0201/5)
Seth, M., *See* Ergun, S., 5:23836
Setlow, R.B., *See* Taichman, L.B., 5:24742
Setzer, H.J., *See* Lesieur, R.R., 5:23610
Sexton, J.C., *See* Skinner, Q.D., 5:23664
Sgro, A.G., Simulations of the ZT-S reversed field pinch, 5:24985
Shafer, J.M., *See* Labadie, J.W., 5:24008
Shaffer, R.E., Chemiluminescent process and detector for monitoring atmospheric contaminants, 5:24625
Shafferman, A., *See* Ilan, Y., 5:24504
Shah, P.M., Analysis of Li/SO_2 system safety, 5:24142
Stability of the $LiAsF_6$:An:SO_2 electrolyte, 5:24169
Shamoo, A.E., *See* Blumenthal, R., 5:24707
Shamovskii, V.G., *See* Bel'chenko, Yu.I., 5:24549
Shamsundar, N., Analysis of energy storage by phase change with an array of cylindrical tubes, 5:23976
Shanmugasundaram, M., Fly ash housing scheme: an experimental project in Neyveli, 5:23471 (METC/SP—79/10(Pt.1), pp 193-204)
Shapira, D., Backward angle cross sections for $^{27}Al + ^{16}O$ reaction products, 5:24898
See Cordell, K.R., 5:24900
Shapiro, A.M., *See* Brick, D., 5:24854
Shapiro, E., *See* Ellison, W., 5:23477
Shapiro, S.L., *See* Campillo, A.J., 5:24693
Shapiro, S.M., *See* Fincher, C.R. Jr., 5:24466
Shareef, I., *See* Aronov, V., 5:24509
Sharfman, N., *See* Bionta, R.M., 5:24852
Sharma, K.C., *See* Chaurey, K.H., 5:23788
Sharma, R.B., *See* Chopra, S.K., 5:23492
Sharma, S.D., *See* Bayfield, J.E., 5:24826
Sharp, D.J., *See* Panitz, J.K.G., 5:24416
Sharp, J.H., *See* Loutfy, R.O., 5:23827, 5:23828
Sharp, K., *See* McCormick, J.R., 5:23815
Sharpey-Schafer, J.F., *See* Haas, B., 5:24923
Shaw, R., *See* Sanford, E., 5:23641
Shearer, J.W., Adiabatic compression of field-reversed plasma, 5:25050 (UCID—18614)
Estimation of neutral-beam-induced field reversal in MFTF by an approximate scaling law, 5:25051 (UCID—18615)
See Hartman, C.W., 5:24976
Sheih, C.M., Estimated dry deposition velocities of sulfur over the eastern United States and surrounding regions, 5:24627
Shelby, J.E., Effect of radiation on the physical properties of borosilicate glasses, 5:24480
Reaction of hydrogen with hydroxyl-free vitreous silica, 5:24469
See Coyle, R.T., 5:23960
Shelfo, S., *See* Giori, C., 5:23450
Sheline, R.K., *See* Mann, L.G., 5:24921
Shellabarger, C.J., *See* Holtzman, S., 5:24749
Shen, S.S., Paramagnetic properties of mixed-matrix NbTi conductors, 5:24513 (CONF-791102—169)
Sher, A., Pyroelectric apparatus including effectively intrinsic semiconductor for converting radiant energy into electric energy, 5:23802
Sherman, F., *See* Liebman, S.W., 5:24712
Sherman, R.H., *See* Kerr, E.C., 5:25069
Sherwood, A.R., *See* Jarboe, T.R., 5:25049
Shewmon, P.G., *See* Sundararajan, G., 5:24390
Shields, K.J., *See* Ahn, Y.K., 5:23835
Shih, S.S., *See* Angevine, P.J., 5:23439
Shipman, J.D. Jr., *See* Boller, J.R., 5:25054
Shizuya, K., 1/N expansion and the theory of composite particles, 5:24882
Shoemaker, A.F., *See* Coyle, R.T., 5:23960

Shore, M., Overall economics in transportation of coal for export, 5:23547
Shugart, H.H., Size and pattern of simulated forest stands, 5:24669
Shukla, V.N., *See* Narayan, J., 5:24431
Shull, G.B., *See* Solbrig, C.W., 5:24081
Shulman, M.J., Implications of meeting the domestic policy review's goal for solar industrial process heat in the year 2000, 5:23914 (SERI/TP—333-429, pp 155-159)
Shulman, R.G., *See* Cohen, S.M., 5:24717
Shulte, C.W., *See* Britt, J.F., 5:23962
Shurtliff, R.W., Microprocessor-controlled scanning densitometer system, 5:24565 (DOE/ID/01570—T4)
Siegrist, J.L., *See* Himel, T.M., 5:24840
Sierer, P.D. Jr., Application of solar energy to continuous belt dehydration, 5:23924 (SERI/TP—333-429, pp 238-243)
Signell, P., *See* Marker, D., 5:24871
See Rijken, T.A., 5:24844
Silbar, R.R., *See* Sternheim, M.M., 5:24893
Silflow, C.D., Sequence complexity of polyadenylated ribonucleic acid from soybean suspension culture cells, 5:24699
Sill, R.C., *See* Davis, R.R., 5:23826
Silvermann, J.P., *See* Brick, D., 5:24854
Sim, J.W., *See* Pierce, R.D., 5:24232, 5:24233
Simmons, J.A., *See* Hammelman, J.E., 5:24543
Simon, R.S., *See* Yates, S.W., 5:24922
Simons, D.J., Prompt striations in ionospheric barium clouds due to a velocity space instability, 5:24802
Simpkins, J.E., *See* Clausing, R.E., 5:25094
Simpson, C.A., *See* Angevine, P.J., 5:23439
Simpson, J.C., *See* White, G.C., 5:24647
Simpson, J.G., Solar concentrator, 5:23964
Simpson, W.I., *See* Ruth, R.P., 5:23808
Sinclair, T.J., *See* Fryer, A.J., 5:24129
Singh, A., *See* Liebman, S.W., 5:24712
Singh, R., *See* Smith, P., 5:23823
Singh, R.N., *See* Keefer, R.F., 5:23517
See Pierce, R.D., 5:24232, 5:24233
Singh, Z., *See* Mann, L.G., 5:24921
Singwi, K.S., *See* Kirczenow, G., 5:24470
Sivers, D., *See* Gottschalk, T., 5:24884
Skeath, P., Bonding of Al and Ga to GaAs(110), 5:24381
Skelton, R., Ultrahigh vacuum system for ISABELLE full cell, 5:24535
Skinner, D.M., *See* McCarthy, J.F., 5:24687
Skinner, Q.D., Phytotoxicity and plant response to aqueous effluents derived from an in situ oil shale process water, 5:23664
Sklad, P.S., Swelling and phase instability in neutron irradiated compositional variants of alloy D9, 5:24420 (DOE/TIC—11202)
Skogerboe, R.K., Potential toxic effects on aquatic biota from oil shale development, 5:23666
Skorikov, N.V., *See* Bakumenko, O.D., 5:24061
Skrovanek, T., *See* Lang, C., 5:24510
Skuja, A., *See* Heisterberg, R.H., 5:24848
Slater, C.O., Analysis of the initial shielding design for the upflow gas-cooled fast reactor (GCFR), 5:24059 (ORNL/TM—7246)
Slater, M.H., Molten Salt Coal Gasification Process Development Unit. Quarterly technical progress report No. 13, April-June 1979, 5:23429 (SAN—1429-52)
Slater, P.J., *See* Hedetniemi, S.M., 5:25112
Slattery, P., *See* Berg, D., 5:24841
Slattery, W.L., Improved equation of state for the classical one-component plasma, 5:24975
Slaughter, A.J., *See* Sandweiss, J., 5:24851
Slaughter, D.R., Neutron yield measurements on a TMX endplug, 5:25005 (UCRL—52923)
Slaughter, J., Outer continental shelf environmental monitoring concerns. Final report, 5:23607 (PB—299861)
Slawson, G.C. Jr, Groundwater quality monitoring of western oil shale development: identification and priority ranking of potential pollution sources, 5:23661 (PB—300536)
Sletten, C.J., Image collapsing concentrators. Interim scientific report No. 2, 5:23951 (DOE/CS/34163—2)
Slike, K., *See* Merrick, E.T., 5:24621
Slonaker, J.F., Role of flyash brick manufacturing in energy conservation, 5:23467 (METC/SP—79/10(Pt.1), pp 85-89)
Smackey, B.M., *See* Avitzur, B., 5:24297
Small, O.H., *See* Culley, R.W., 5:23500
Small, T.R., *See* Rabenhorst, D.W., 5:24099
Smalley, R.E., *See* Hopkins, J.B., 5:24812
Smartt, H.B., Welding industry. Potential for energy conservation, 5:24290 (EGG—2027)
Smilansky, U., *See* Stokstad, R.G., 5:24916
Smirnov, A.M., *See* Gryazed, V.M., 5:24079
Smith, A.M., *See* Wright, A.L., 5:24086
Smith, A.R., *See* Richman, C., 5:24725
Smith, C.C., Solar supplement to laundry drying, 5:23915 (SERI/TP—333-429, pp 161-168)
Smith, C.F., *See* Meyer, R.A., 5:24913
Smith, C.G., *See* Hauge, P.S., 5:24971
Smith, C.L., Largest use of fly ash-scrubber sludge disposal, 5:23476 (METC/SP—79/10(Pt.1), pp 312-327)
Smith, D.E.A., Measurement of radiative $\pi^+ p$ scattering below the Δ^{++} (1232) resonance, 5:24853
Smith, D.L., *See* Henderson, R.P., 5:25060
Smith, D.R., Design and performance of an 11 kW Solar Array Simulator, 5:23852 (SAND—80-0873C)
Smith, G.J., *See* Cizewski, J.A., 5:24932
Smith, G.R., *See* Adams, G.S., 5:24911
See Kaellne, J., 5:24889
Smith, G.S., Dried, irradiated sewage solids as supplemental feed for cattle, 5:24331 (SAND—80-0989C)
Smith, H.S., In vitro properties of epithelial cell lines established from human carcinomas and nonmalignant tissue, 5:24705
Smith, J.L., *See* Roof, R.B., 5:24377
Smith, J.W., High temperature reactions of oil shale minerals and their benefit to oil shale processing in place, 5:23635
Smith, M.A., *See* Blue, J.L., 5:24244
Smith, N.L., *See* Meyer, R.A., 5:24913
Smith, P., Reverse current-voltage characteristics of indium tin oxide/silicon solar cells under illumination, 5:23823
Smith, P.A., *See* Alford, W.P., 5:24918
Smith, R.D., Solid fuel fired gas turbine system having continuously regenerating granular filter, 5:24020
Smith, R.E., Nuclear fuel services waste characterization and waste removal system, 5:23714 (RHO-CD—883)
Smith, R.J., Photoemission studies of hydrogen chemisorption on Nb, 5:24399
Smith, R.M., *See* Routson, R.C., 5:23740
Smith, S.E., Potential for the use of solar energy in the production of process heat in Arizona, 5:23916 (SERI/TP—333-429, pp 169-173)
Smith, W.R., Solar adaptation of dome structures, 5:23897
Smither, R.K., *See* Haas, B., 5:24923
Snow, R.H., Comparison of dielectric heating and pyrolysis of eastern and western oil shales, 5:23632
Snyder, A., *See* Brick, D., 5:24854
Snyder, M.K., *See* Nebgen, J.W., 5:23506
Snyder, T.P., Frequency-dependent selection at the PGM-1 locus of Drosophila pseudoobscura, 5:24713
Soelistijo, U.W., Role of energy in the Indonesian economy, 1975 to 2000, 5:24206 (PB—301135)
Solar, R.J., *See* Morley, D., 5:24149
Solbrig, C.W., LOFT Experimental Programs Division. Volume II. Calibration of the LOFT modular DTT and the LOFT production DTT with a small drag disc, 5:24081 (EGG/LTR-LO—0080-113)
Soldat, J.K., *See* Napier, B.A., 5:24754
Solem, J.C., *See* Baldwin, G.C., 5:24525
Solomon, A.D., *See* Deal, R.M., 5:24100
Solomon, I., *See* Giori, C., 5:23450
Somerton, C.W., Convective instability of a volumetrically heated porous bed, 5:23978
Sommer, W.F., Post irradiation dose determination of 800 MeV proton irradiated aluminum from LAMPF experiment 407, 5:24422 (LA—8351-MS)
Sommerlad, R.E., Central receiver solar energy system for an oil refinery, 5:23917 (SERI/TP—333-429, pp 181-185)
Somorjai, G.A., *See* Firment, L.E., 5:24406
Sontheimer, H., *See* Kuehn, Ing.W., 5:24666
Soo, W.J., *See* Schwarz, R.I., 5:24708
Sorensen, P.E., *See* Jones, R.O., 5:23657
Souder, P.S. Jr., Economic considerations of rail and pipeline transportation of coal, 5:23549
Sowell, R.R., *See* Mattox, D.M., 5:23954
Soyster, A.L., Literature review on capacity expansion planning under uncertainty. Phase II, 5:24211 (DOE/TIC—11177)
Spalding, B.P., Effects of divalent metal chlorides on respiration and extractable enzymatic activities of douglas-fir needle litter, 5:24769
Sparks, L.E., *See* VanOsdell, D.W., 5:24031
Specht, J.R., *See* Holt, R.J., 5:24897
Specking, W., *See* Easton, D.S., 5:24397
Spejewski, E.H., UNISOR facility: recent developments and future directions, 5:24552 (CONF-790976—10)
Sperduto, A., *See* DiRienzo, A.C., 5:24929
Spicer, W.E., *See* Skeath, P., 5:24381
Spickard, G.M., *See* Waitzman, D.A., 5:23787
Spitzer, R.H., *See* Schuhmann, R. Jr, 5:23414
Spooner, S., *See* Kenik, E.A., 5:24394
Springer, R.W., Quantitative characterization of high strength aluminum foils vapor deposited on curved surfaces, 5:24380
Springhorn, S.S., *See* Lacks, S.A., 5:24675
Springmann, H., Optimization of air separation plants for combined cycle MHD-power plant applications, 5:24222 (DOE/NASA/2674—80/10)
Squires, A.M., Development and application of analytical techniques to chemistry of donor solvent liquefaction. Quarterly progress report, March-May 1979, 5:23448 (FE—2696-T4)
Sredniawski, J.J., *See* Cecchi, J.L., 5:25099
Srinivasan, S., Fuel cells for electric utility and transportation applications, 5:24234 (BNL—27452)
Srinivastan, R., *See* Shamsundar, N., 5:23976
Staats, P.A., *See* Vander Sluis, K.L., 5:24993
Stabley, J.D., High power very long pulse testing of a 200 kv. tetrode regulation tube, 5:25055

Stadjuhar, S.A., *See* Brown, K.C., 5:23910
Staebler, D.L., Optically induced conductivity changes in discharge-produced hydrogenated amorphous silicon, 5:24467
Stagner, M.J., Production of SNG from shale oil by catalytic gasification in a steam-hydrogen atmosphere, 5:23629 (LETC/RI—79/11)
Staib, P., X-ray photoelectron spectroscopy (XPS) studies of oxygen and carbon bonding to tokamak walls, 5:25098
See Dylla, H.F., 5:25097
Staiger, P.J., Summary and evaluation of the parametric study of potential early commercial MHD power plants (PSPEC), 5:24218 (DOE/NASA/2674—80/9)
Stamer, P.E., *See* Brick, D., 5:24854
Stamper, J.A., *See* Ripin, B.H., 5:25082
Stang, L., Environmental, Health, and Safety Considerations, 5:23803 (BNL—27720)
Stangeland, B.E., *See* Sullivan, R.F., 5:23446
Staphanakis, S.J., *See* Young, F.C., 5:24563
Stapleton, R.E., *See* Hopkins, R.H., 5:23809, 5:23810
Stark, I.A., Slag: a useful form of ash, 5:24312 (METC/SP—79/10(Pt.2), pp 784-786)
Starn, R.E. Jr., *See* Scheule, H.J., 5:24358
Stattel, P., *See* Skelton, R., 5:24535
Steele, O.P. III, *See* Welch, F.H., 5:24064
Steele, T.D., The Yampa River Basin, Colorado and Wyoming--a preview to expanded coal-resource development and its impacts on regional water resources. Water-resources investigations (final), 5:24658 (PB—300815)
Steffens, E., *See* Egelhof, P., 5:24892
Steiger, H.A., *See* Dunlay, J.B., 5:24336
Stein, F.P., *See* Schiesser, W.E., 5:23423
Stein, N., *See* Cindro, N., 5:24909
Stein, T.R., *See* Angevine, P.J., 5:23439
Steinberg, M., Thermochemical cycles for the production of hydrogen, 5:23768
Steinborn, T.L., *See* Knauss, K.G., 5:23748
Steinhauer, L.C., Plasma rotation in reversed-field theta pinches, 5:25025 (MSNW—80-1144-1)
Steinman, D.A., *See* Crawley, R.L., 5:23762
Steinmeyer, R.H., *See* Tadlock, W.E., 5:23753
Stelmack, L.A., *See* Flint, B.K., 5:24521
Stelson, P.H., *See* Shapira, D., 5:24898
Stelts, M.L., *See* Cizewski, J.A., 5:24932
Stephens, F.B., State-of-the-art hydrogen sulfide control for geothermal energy systems: 1979, 5:23993 (DOE/EV—0068)
Stephens, F.S., Phenomena at very high spins, 5:24939 (LBL—10645)
See Yates, S.W., 5:24922
Sternheim, M.M., Interpretation of quasielastic pion scattering coincidence experiments, 5:24893
Stevens, R.D., Agt guideway and station technology. Volume 8. Weather protection concepts. Final report, 5:24343 (PB—299746)
Stevens, W.J., *See* Krauss, M., 5:24522
Stewart, B.M., *See* Brown, A., 5:23658
Stickford, G.H., *See* Corliss, J.M. II, 5:23874
See Droege, J.W., 5:23451
Stickler, J.J., Simulation of an urban battery bus vehicle. Final report June-December 1978, 5:24345 (PB—300306)
Stigliani, W., *See* Mohnen, V.A., 5:24619
Stine, W.B., *See* Carnegie, E.J., 5:23921
Stirling, W.L., *See* Kim, J., 5:24987
See Menon, M.M., 5:25063
Stockdale, J.A.D., Collisional ionization of Cs and K by O_2, 5:24823
Stocks, G.M., *See* Faulkner, J.S., 5:24958
Stokes, B.A., *See* Mendis, M.S., 5:23537
Stokstad, R.G., Fusion of $^{16}O+/sup$ 148,150,152,154/Sm at sub-barrier energies, 5:24916
Stone, J.P., *See* Holtzman, S., 5:24749
Storch, N., Application of FRAMIS to K/sub D/ data, 5:23747 (UCID—18651)
Stowers, I.F., Need for a contamination control textbook, 5:24517 (UCRL—84327)
Strachan, D.M., *See* Ross, W.A., 5:23738
Strain, R.V., *See* Gross, K.C., 5:24051
Strait, J., *See* Himel, T.M., 5:24840
Strauch, K., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Strohlein, M.G., *See* Blue, J.L., 5:24244
Strongin, M., Thermal decomposition of silane to form hydrogenated amorphous Si, 5:24367
Strottman, D., *See* Oset, E., 5:24947
Struble, G.L., *See* Mann, L.G., 5:24921
Strunk, W.D., Cylinder overpack phenolic foam shock testing, 5:24518 (K/P—6567)
Stucker, J.P., Energy efficiency of various transportation modes, 5:24263 (PB—299994)
Studhalter, W.R., Design study of a two-phase turbine bottoming cycle. Final report, 5:24309 (DOE/ET/15350—T1)
Styron, R.W., Bottom ash lightweight aggregate, 5:23472 (METC/SP—79/10(Pt.1), pp 245-253)
See Fowler, G.G., 5:23489
See Hurst, V.J., 5:23468
Su, C.Y., *See* Skeath, P., 5:24381
Subramaniam, T.K., *See* Bailey, E.E., 5:23783
Suckewer, S., Conditions for soft x-ray lasing action in a confined plasma column, 5:24528
Sugama, T., High temperature chemically resistant polymer concrete, 5:24443
Sugarbaker, E., *See* Brown, R.E., 5:24917
Sugimitsu, T., Investigation of a large solid angle pion channel for a medical application utilizing current sheets and solenoid elements, 5:24554 (LA—8356-MS)
Sullivan, P.J., Communication requisites to socio-institutional adjustments to technological changes in coal transportation, 5:23557
Sullivan, P.W., *See* Coleman, J.J., 5:23947
See Kohler, J.T., 5:23946, 5:23948
Sullivan, R.F., Refining and upgrading of synfuels from coal and oil shales by advanced catalytic processes. Laboratory and Pilot Plant studies of the processing of SRC-I. Second interim report, 5:23446 (FE—2315-45)
Sundararajan, G., Hydrogen attack of HSLA steels, 5:24390
Sunier, J.W., *See* Brown, R.E., 5:24917
See Cindro, N., 5:24909
Sutton, R.B., *See* Bionta, R.M., 5:24852
Suydam, B.R., Growth rates of interchange modes in the dense z-pinch and gas blanket effects, 5:25024 (LA—8340-MS)
Swab, P., Characterization of black Ge selective absorbers, 5:24411
Swain, M.R., *See* Adt, R.R. Jr., 5:24357
Sweeney, M.A., Coupling of electron-beam energy to an expanding thick-shelled target, 5:25065
Swegle, J.W., Constitutive equation for porous materials with strength, 5:24387
Swenson, D.A., *See* Sugimitsu, T., 5:24554
Swiatecki, W.J., *See* Randrup, J., 5:24948
Symons, P.C., *See* Carr, P., 5:24106
Syn, C.K., *See* Morris, J.W. Jr., 5:24383
Szostak, R.M., A pollution-free system for the economic utilization of municipal solid waste, task 10, electrochemical recovery of non ferrous metals derived from municipal refuse, 5:24326 (PB—299753)
Szwarc, R., *See* Larrick, B.F., 5:24161

T

Tabor, S.L., *See* Prosser, F.W. Jr., 5:24906
Tadlock, W.E., Gas generation by self-radiolysis of tritiated waste materials, 5:23753
Taflove, A., *See* Snow, R.H., 5:23632
Taft, C.D., *See* Brick, D., 5:24854
Taft, H.D., *See* Sandweiss, J., 5:24851
Talchman, L.B., Repair of ultraviolet light damage to the DNA of cultured human epidermal keratinocytes and fibroblasts, 5:24742
Takasugi, E., Recombination model and multimeson production, 5:24869
Takeda, H., *See* McLaughlin, A.C., 5:24697
Takusagawa, F., Neutron diffraction study of quinolinic acid recrystallized from D_2O: evaluation of temperature and isotope effects in the structure, 5:24460
Talley, A.D., *See* Romero, R., 5:23729
Talmage, R.V., *See* Vanderwiel, C.J., 5:24698
Tamor, M.A., *See* Smith, D.E.A., 5:24853
Tanaka, F., *See* Kawabe, N., 5:23606
Tandon, J.L., *See* Masuyama, A., 5:24479
Tang, H.H.K., Exactly central heavy-ion collisions by nuclear hydrodynamics, 5:24928
Taras, P., *See* Haas, B., 5:24923
Tarle, G., *See* Salamon, M.H., 5:24950
Tartof, D., Inhibition of cytotoxic T lymphocytes with concanavalin A, 5:24703
Tata, X., *See* Takasugi, E., 5:24869
Tate, L.R., *See* McCullough, J.F., 5:23700
Tattershall, P., *See* Doran, R.J., 5:24172
Tauber, H., Western coal project, 5:23567
Taureg, H., *See* Himel, T.M., 5:24840
Taylor, D., Evaluation of coal/oil/water slurry (COWS) emulsions produced by an on-line cavitation emulsification process, 5:24023 (FE—3162-T1)
Taylor, D.R., *See* Skogerboe, R.K., 5:23666
Taylor, H., Li/SO_2 cells of improved stability, 5:24141
Taylor, L.T., *See* Squires, A.M., 5:23448
Taylor, S., *See* Brick, D., 5:24854
Teague, L.S., Secondary minerals found in the cores DC2 A1 and DC2 A2 taken from the Grande Ronde Basalt Formation, Pasco Basin, Washington, 5:23730 (LBL—10387)
Tedder, D.W., Methods for separating actinides from reprocessing and refabrication plant wastes, 5:23715 (CONF-791112—63)
Teig, L., *See* Sandweiss, J., 5:24851
Teikovtsev, A.A., *See* Gryazev, V.M., 5:24060
Temple, P.L., *See* Coleman, J.J., 5:23947
See Kohler, J.T., 5:23946, 5:23948
Tennery, V.J., *See* Till, J.E., 5:23704
Tenti, G., *See* Boley, C.D., 5:24825
Tepley, N., *See* Wallace, W.D., 5:23643
Terner, J., Time-resolved resonance Raman spectroscopy of intermediates of bacteriorhodopsin: the bK_{590} intermediate, 5:24685
Ternes, M.P., Thermal Energy Storage Test Facility, 5:24249 (CONF-791242—2)
Tether, C.D., *See* Kenworthy, L.D., 5:24072
Thayer, P.A., Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))

Themelis, M.P., *See* Hornig, C.F., 5:23805
Thill, R.E., *See* Radcliffe, K.S., 5:23617
Thoe, R.S., *See* Sellin, I., 5:24819
Thoem, T., EPA regulatory/research program, 5:23669
Thoem, T.L., EPA Oil Shale Research/ Regulatory Program, 5:23670
Thomas, E., Retention and re-emission of 0.125— 1-keV deuterium in stainless steel, 5:24808
Thomas, E.W., *See* Metz, W.A., 5:24806
Thomas, G., *See* Narasimha Rao, B.V., 5:24378
See Okada, M., 5:24373
See Wu, W., 5:24384
Thomas, G.H., *See* Cleaver, J.E., 5:24743
Thomas, M.T., Sulfur and oxygen chemistry at free surfaces and grain boundaries of iron alloys, 5:24407
Thomas, M.Z., *See* Landry, E.F., 5:24726
See Vaughn, J.M., 5:24731
Thomas, R.E., *See* Tolle, D.A., 5:23528
Thomas, R.H., Radiation monitoring. Lecture 26, course on advances in radiation: International School of Radiation Damage and Protection, Erice, Italy, September 1979, 5:24631 (LBL—9814)
Thomas, R.L., *See* Wallace, W.D., 5:23643
Thomas, S.J., *See* Marling, J.B., 5:24497
See Watkins, D.E., 5:24475
Thome, D.J., *See* Potter, G.D., 5:24630
Thompson, C., *See* Schultz, H.L., 5:24617
Thompson, J., *See* Doran, R.J., 5:24172
Thompson, L.H., Validation of conditions for efficient detection of HPRT and APRT mutations in suspension-cultured Chinese hamster ovary cells, 5:24710
Thompson, P., *See* Berg, D., 5:24841
Thompson, P.B., *See* Haubenreich, P.N., 5:25047
Thompson, T.N., *See* Auer, H.E., 5:24692
Thompson, W.L., Deep penetration calculations, 5:24057 (LA-UR—80-1159)
Thorn, C.E., *See* Kubono, S., 5:24908
Thornton, J.A., *See* Jonath, A.D., 5:23807
Thornton, S.I., Delayed compaction of high calcium fly ash stabilized soil, 5:23499 (METC/SP—79/10(Pt.2), pp 748-757)
Thornton, S.T., *See* Cordell, K.R., 5:24900
Thunder, A., *See* Jumel, Y., 5:24147
Tibbitts, E.E., Nickel-iron alloy corrosion in a sealed pyrotechnic system, 5:24413 (MLM—2707(OP))
Tieke, O., *See* Dudek, M, 5:23592
Till, J.E., Reprocessing nuclear fuels of the future: a radiological assessment of advanced (Th,U) carbide fuel, 5:23704
See Kocher, D.C., 5:24628
Tilley, D.R., *See* Roberson, N.R., 5:24912
Tincher, W.C., *See* Cook, F.L., 5:24300
Ting, J., *See* Petrasso, R., 5:24999
Tinklenberg, R., Thermogram analysis of several solar collector arrays, 5:23969
Tinoco, I. Jr., *See* Winkle, S.A., 5:24679
Tippets, F.E., Progress of LMFBR steam generator testing in the US, 5:24056 (GEFR-SP—196)
Tobias, M.L., Modeling decay heat-induced melting of a concrete slab by use of the general heat conduction code HEATING 5, 5:24095 (ORNL/ TM—7211)
Tobin, R.J., Nonequilibrium phenomena in flashing water used as an HCDA source simulant. Technical report No. 8, 5:24096 (SAN—0115-T7)
Todd, L.J., *See* Schultz, R.V., 5:23453
Todo, T., *See* Yonei, S., 5:24738
Toki, N., Floating-type anti-oil anti-impact and anti-wave barrier, 5:23608
See Kasai, H., 5:23609
Tolk, K.M., *See* Bullion, T.M., 5:25059
See Gully, J.H., 5:25057
Tollaksen, S.L., *See* Giometti, C.S., 5:24673
Tolle, D.A., Environmental assessment of coal cleaning processes; selection of test sites for source test program. Final report December 1977-December 1978, 5:23528 (PB—300673)
Environmental assessment of coal cleaning processes; master test plan. Final report June 1977-January 1979, 5:24652 (PB—300670)
Tomlinson, E.T., *See* Slater, C.O., 5:24059
Tommerdahl, J.B., *See* Eaton, W.C., 5:24614
Tompkins, J., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Tong, G., *See* Schultz, H.W., 5:24327
Tonutti, M., *See* Himel, T.M., 5:24840
Topouzian, A., Research on electrodes and electrolyte for the Ford sodium-sulfur battery. Annual report 30 June 1976-31 October 1977, 5:24428 (PB—301409)
Sodium-sulfur battery: a progress report, 5:24160
Torbert, R.B., *See* Mozer, F.S., 5:24803
Tortora, J., *See* Brick, D., 5:24854
Townsend, F.C., *See* Peterson, R.W., 5:23645
Tranquada, J.M., *See* Ingalls, R., 5:24465
Trautmann, W., *See* Haas, B., 5:24923
Traynor, G.W., *See* Hollowell, C.D., 5:24624
Trent, B.C., *See* Young, C., 5:23638
Trepagnier, P.C., *See* Brick, D., 5:24854
Trice, J.B., Operational experience of the LaFrance, South Carolina solar process hot water system, 5:23920 (SERI/TP—333-429, pp 199-204)
Solar production of low pressure steam for processing of orange juice, 5:23928 (SERI/TP—333-429, pp 263-265)
Trief, L., New Trief cement process: what has become of Trief cement and portland industry since 1976, 5:23493 (METC/SP—79/10(Pt.2), pp 653-658)
Trilling, G.H., *See* Himel, T.M., 5:24840
Tripp, L.J., *See* Ackerman, F.J., 5:23639
Trujillo, P., *See* Smith, G.S., 5:24331
Tsacoyeanes, J.C., Pilot program to identify valve failures which impact the safety and operation of light water nuclear power plants, 5:24042 (ALO—75)
Tsai, C.C., *See* Kim, J., 5:24987
See Menon, M.M., 5:25063
See Schwenterly, S.W., 5:25087
Tsai, M., Sputtered oxide/indium phosphide junctions and indium phosphide surfaces, 5:24294
Tsang, F.Y., Current status of the hollow fiber sodium-sulfur cell, 5:24124
Tse, C.F., Biochemical studies of mouse brain tubulin: colchicine binding (DEAE-cellulose filter) assay and subunits (α and β) biosynthesis and degradation (in newborn brain), 5:24695 (UR—3490-1559)
Tserruya, I., Complete fusion of ^{12}C with ^{20}Ne, 5:24907
See Stokstad, R.G., 5:24916
Tsongas, G.A., Field study of moisture damage in walls insulated without a vapor barrier. Final report for the Oregon Department of Energy, 5:24245 (ORNL/Sub—78/97726/1)
Tsurukin, Yu.P., *See* Bakumenko, O.D., 5:24061
Tucci, P., *See* Meyer, W., 5:24660
Tucker, G.B., Bibliography of the geology of the Columbia Basin and surrounding areas of Washington, 5:23739 (RHO-BWI-C—59)
Tucker, M.O., Effect of open porosity on the re-solution of fission gas from grain-edge bubbles, 5:24424
Tucker, P.M., *See* Allen, G.C., 5:24419
Turchan, M.J., *See* Holleck, G.L., 5:24135
Turcotte, R.P., *See* Ross, W.A., 5:23738
Turnbull, J.A., *See* Tucker, M.O., 5:24424
Turner, A.P.L., Cyclic creep of Type 304 stainless steel during unbalanced tension-compression loading at elevated temperature, 5:24388
Tuvnes, B., Field tests with lithium/SO_2 batteries, 5:24140
Tverdovskii, N.D., *See* Bakumenko, O.D., 5:24061
Tye, S.H., *See* Guth, A.H., 5:24800
Tyler, J.M., Purification of two spectrin-binding proteins: biochemical and electron microscopic evidence for site-specific reassociation between spectrin and bands 2.1 and 4.1, 5:24704
Tzeng, L., *See* Sandweiss, J., 5:24851

U

Uckan, N.A., Ring power balance scaling: implications for a reactor, 5:25016 (ORNL/TM—7302)
Uetani, Y., FeS/Li organic electrolyte cell, 5:24118
Uhlhorn, C.D., *See* Tserruya, I., 5:24907
Ulerich, N.H., Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 2. Tasks II and III report: experimental work, sorbent selection technique. Final report, November 1, 1976-July 31, 1977, 5:24033 (EPRI-FP—1307(Vol.2))
See O'Neill, E.P., 5:24032
Ullery, S.J., The Environmental Protection Agency and the Kaiparowits Power Project: a case study of EPA's performance of its environmental review responsibilities, 5:24028 (PB—300391)
Ullrich, C.R., *See* Santhanam, C.J., 5:23480
Ullrich, R.L., Induction of lung tumors in RFM mice after localized exposures to x rays or neutrons, 5:24748
Uppuluri, V.R.R., Limiting behavior of sampling proportional to random size, 5:23572 (CONF-791241—1)
Ure, R.W. Jr, Refractory materials for coal fueled mhd power generation. Final report, 5:24436 (PB—301095)
Uri, N.D., Energy demand and interfuel substitution in India, 5:24198
Ursic, J., *See* Kocuvan, I., 5:24462
Utter, S., Drilling and casing a large-diameter shaft in he Piceance Creek Basin, 5:23623

V

Vaill, R.E., *See* Hill, F.E., 5:24136
Vainchenker, W., *See* Breton-Gorius, J., 5:24729
Vallet, C.E., Electrolysis of molten $NaNO_3$-$AgNO_3$ as test of a model of transport in batteries, 5:24122 (CONF-781063—7)
van der Geest, J.M.P., *See* Noomen, A., 5:24503
van Dyck, O.B., Medium-energy physics program. Quarterly progress report, May 1-July 31, 1979, 5:24553 (LA—8293-PR)
van Hulsteyn, D.B., *See* Minerbo, G.N., 5:25080
van Steenbergen, A., Optimization of a synchrotron radiation source, 5:24556 (BNL—27654)
Van Tyne, A.M., *See* Kamakaris, D.G., 5:23618
Van Voast, W.A., Strip coal mining and mined-land reclamation in the

hydrologic system, southeastern Montana. Project completion report, 5:23530 (PB—301253)
Van Voris, P., *See* Tolle, D.A., 5:24652
Van Winkle, W., Population-level assessments should be emphasized over community/ecosystem-level assessments. Environmental Sciences Division Publication No. 1535, 5:24025 (CONF-800543—3)
See Barnthouse, L.W., 5:24026
Van Zuiden, G.J., *See* Duncan, R.T., 5:23912
Vander Sluis, K.L., Evaluation of a high power submillimeter pulsed laser system, 5:24993 (CONF-800138—1)
Vanderborgh, N.E., *See* Brown, L.F., 5:23541
Vanderwiel, C.J., Comparison of the effects of prostaglandin E_2 and parathyroid hormone on plasma calcium concentration and osteoclast function, 5:24698
VanDevender, J.P., *See* Burns, E.J.T., 5:24481
Vandevender, S.G., State policies and requirements for management of uranium mining and milling in New Mexico. Volume II. Water availability in the San Juan Structural Basin, 5:23754 (SAND—78-1331)
VanKuiken, J.C., *See* Guziel, K.A., 5:23564
VanOsdell, D.W., EPA/IERL-RTP pilot electrostatic precipitator: selected experiments, 1978, 5:24031 (EPA—600/7-79-238)
Vantine, H.C., Hysteresis-corrected calibration of manganin under shock loading, 5:24296
Varma, M.N., Energy deposition in nanometer regions by 377 MeV/nucleon ^{20}Ne ions, 5:24723
Vasan, S., Holmes-Stretford process for desulfurization of tail gases from acid-gas systems, 5:23415
Vastola, F., *See* Liscinsky, D.S., 5:23454
Vaughn, J.M., Modified procedure for the recovery of naturally accumulated poliovirus from oysters, 5:24727
Survey of human enterovirus occurrence in fresh and marine surface waters on Long Island, 5:24731
See Landry, E.F., 5:24726
Veatch, F., Recovery of bitumen from tar sands, 5:23640
Veatch, M.D., Preliminary subsurface hydrologic considerations: Columbia River Plateau Physiographic Province. Assessment of effectiveness of geologic isolation systems, 5:23735 (PNL—2859)
Vella, E.N., *See* Himel, T.M., 5:24840
Vicale, T.J., *See* Vaughn, J.M., 5:24727, 5:24731
Vidal, R.A., *See* Himel, T.M., 5:24840
Videau, I., *See* Himel, T.M., 5:24840
Vijuk, R.M., *See* Bishop, B.A., 5:24054
Vinson, R.P., Methane encountered at the Bureau of Mines oil shale shaft, 5:23653
Virchow, C.F., Microprocessor-controlled time domain reflectometer for dynamic shock position measurements, 5:24586
Virgona, J.E., *See* Farrier, D.S., 5:23667
Vitko, J., *See* Coyle, R.T., 5:23960
Vitkovitsky, I.M., *See* Burton, J.K., 5:25056
Vizcaino, H., Great Divide Basin drilling project Sweetwater County, Wyoming, 5:23675 (GJBX—51(80))
Vlasak, D.L., *See* Midurski, T.P., 5:24353
Vo-Dinh, T., Room temperature phosphorimetry for the analysis of environmental systems, 5:24651 (CONF-791059—8)
Vodonick, E.J., *See* Gunderson, J., 5:24352
Vogt, J.F., *See* Rosell, F.E. Jr., 5:23767
Voloshina, E.A., Oxygen effect and adaptive reactions of cells. Report 2. Kinetics of respiration of tumor cells differing in initial respiration level, 5:24747
von Essen, C., *See* Richman, C., 5:24725
Vondy, D.R., Solving the nuclear reactor core problems, 5:24071 (CONF-791186—1)
Vortman, L.J. III, Prediction of ground motion from underground nuclear weapons tests as it relates to siting of a nuclear waste storage facility at NTS and compatibility with the weapons test program, 5:23746 (SAND—80-1020/1)
Vortman, L.J. IV, Prediction of ground motion from underground nuclear weapons tests as it relates to siting of a nuclear waste storage facility at NTS and compatibility with the weapons test program, 5:23745 (SAND—80-1020/1)
Voss, A., *See* Schmitz, K., 5:24204
Voss, D.E., Low energy neutral outflux from the PLT Tokamak, 5:24994 (PPPL—1664)
UHV compatible chopper system, 5:25000
Voss, R.F., All-Nb low-noise dc SQUID with 1-μm tunnel junctions, 5:24516
Vygodskaya, A.L., *See* Voloshina, E.A., 5:24747

W

Wachspress, E.L., High-order curved finite elements, 5:25110 (KAPL—4134)
Wacker, K., *See* Partridge, R., 5:24842
See Peck, C.W., 5:24838
Wade, M., Race-specific molecules that protect soybeans from Phytophthora megasperma var. sojae, 5:24728
Wagner, O.C., *See* Himey, A., 5:24167
Wagschal, J.J., Covariances of fission-integral measurements at the NBS ^{252}Cf and ISNF facilities and at the ORNL-PCA facility, 5:24070 (CONF-791051—23)
Wahlig, M., Overview-absorption/Rankine solar cooling program, 5:23887 (LBL—10770)
See Dao, K., 5:23888
Wainwright, E.S., *See* Hornig, C.F., 5:23805
Waltzman, D.A., Coal technology for ammonia production, 5:23787
Walch, S.P., Calculated spectroscopic constants for the $X\ ^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$, ^3Pi, and ^1Pi states of CCO. The heat of formation of CCO, 5:24814
Wali, E., *See* Dao, K., 5:23888
Walker, G.W., Diagnostic techniques for performance evaluation of fuel cells. I. Comparison of carbon monoxide tolerance of selected anodes, 5:24239
Walker, H.C. Jr., *See* Eckstrom, D.J., 5:24527
Walker, J.S., Stresses in liquid lithium modules in a tokamak blanket due to a changing poloidal magnetic field, 5:25062 (CONF-791102—168)
Walker, P.L., *See* Morgan, M.E., 5:23456
Walker, P.L. Jr., *See* Maloney, D.J., 5:23455
Wallace, T.C., *See* Behrens, R.G., 5:24395
Wallace, T.C. Sr., *See* Riley, R.E., 5:24455
Wallace, W.D., Ultrasonic velocity and elastic constants of Antrim oil shale, 5:23643 (FE—2346-37)
Walsh, J.J., Consequences of natural upwelling in oligotrophic marine ecosystems, 5:23862 (BNL—27710)
Shelf-sea ecosystems, 5:24650 (BNL—27406)
Walsh, P.J., *See* Griffin, G.D., 5:24762
Walsh, P.M., *See* Bracco, F.V., 5:23426
Walsh, T., *See* Berg, D., 5:24841
Walters, W.B., Radioactive decay studies at TRISTAN II. Progress report, July 1, 1979-March 31, 1980, 5:24887 (DOE/ER/10494—1)
Waltz, R.E., Convective amplification of drift waves and thermal fluctuation levels in a stable plasma, 5:25040
Wampler, W.R., Probe measurements of impurities in the plasma boundary of PLT, 5:25004 (SAND—79-2338C)
Wang, C.H., *See* Heisterberg, R.H., 5:24848
Wang, J.C., *See* Harkness, J.D., 5:24134
Wang, J.L.F., Method of manufacturing a niobium-aluminum-germanium superconductive material, 5:24362
Wang, L.C., Baeklund transformations, conservation laws and linearization of the self-dual Yang-Mills and chiral fields, 5:24875 (BNL—27617)
Wang, P.S., X-ray induced auger electron spectroscopic studies on aluminum metal surface films in aluminum/iron oxide thermites, 5:24437 (MLM—2711(OP))
See Moddeman, W.E., 5:24580
Wang, Y., *See* DuBow, J., 5:23646
Wangen, L.E., *See* Gladney, E.S., 5:23532
Warburton, D.L., Five year storage tests of solid state Ag/I_2 batteries, 5:24130
Ward, D., *See* Haas, B., 5:24923
Warmack, R.J., *See* Stockdale, J.A.D., 5:24823
Warner, J.W., *See* Steele, T.D., 5:24658
Warr, C., *See* Hine, G.J., 5:24562
Wasan, D.T., Mechanism of oil bank formation, coalescence in porous media and emulsion stability. Annual report, June 1978-May 1979, 5:23575 (DOE/BC/10069—6)
Washburn, J., *See* Masuyama, A., 5:24479
See Wu, W., 5:24384
Washington, L.J., *See* McNamara, P.H., 5:23634
Washington, L.J. Jr., Energy from in situ processing of antrim oil shale. Quarterly technical progress report, October-December 1979, 5:23627 (FE—2346-58)
Energy from in situ processing of antrim oil shale. Quarterly technical progress report, January-March 1980, 5:23628 (FE—2346-64)
Waterland, L.R., Environmental assessment of stationary source NOx control technologies. Annual report no. 2, June 1977-June 1978, 5:24547 (PB—300469)
Waterstone, P., *See* White, A., 5:25117
Watkins, D.E., Observation of resonantly enhanced degenerate four-wave mixing in doped alkali halides, 5:24475
Watson, A., Longfellow solar demonstration project, 5:23901
Watson, J.D., *See* Young, C., 5:23638
Watson, J.S., *See* Canon, R.M., 5:23465
Watson, J.W., *See* Zisman, M.S., 5:24903
Watson, R.E., *See* Krinsky, S., 5:24557
Watson, R.L., X-ray emission in heavy-ion collisions. Progress report, April 1, 1979-March 31, 1980, 5:24805 (DOE/ER/06036—3)
Watson, T.M., Manufacturing techniques for hermetically sealed lithium organic electrolyte cells, 5:24116
Watts, K.N., *See* Wilson, N.G., 5:25096
Watts, T.L., *See* Brick, D., 5:24854
Weatherford, G., *See* Carey, D., 5:23534
Weatherford, W.D. Jr., *See* Fodor, G.E., 5:23599
Weaver, J.H., *See* Rosei, R., 5:24401
Webb, J., Reliability and durability study of a thermal receiver utilizing ASI

Type 316 stainless steel in contact with molten aluminum, 5:23860 (SERI/TP—641-653)
Webb, R.B., *See* Hass, B.S., 5:24766
Weber, F.W., *See* Dunlop, J.D., 5:24132
Weber, H., Method of producing form coke, 5:23411
Weber, T., *See* Kuesebauch, W., 5:23771
Webster, T.F., *See* Levis, A.H., 5:24298
Webster, W.C., Estimating the leaching potential of coal combustion by-products, 5:23483 (METC/SP—79/10(Pt.2), pp 471-481)
Wegner, H.E., *See* DiRienzo, A.C., 5:24929
Wegner, J., *See* Carey, D., 5:23534
Weinreich, B., *See* Taylor, D., 5:24023
Weinstein, B.W., Characterization techniques for high quality ICF targets, 5:23760 (UCRL—82530)
Weiss, J.M., *See* Himel, T.M., 5:24840
Weiss, R., *See* Sanyal, S., 5:23994
Weiss, W., *See* Egelhof, P., 5:24892
Weitzner, H., Stability of long, thin axisymmetric mirror machines, 5:25030
Welch, F.H., Evaporative removal of sodium from reactor components, 5:24064
Welch, G.P., *See* Mattern, M.R., 5:24737
Weldon, W.F., *See* Bullion, T.M., 5:25059
See Gully, J.H., 5:25057
See Mayhall, D.J.T., 5:25058
Welford, W.T., Optics of nonimaging concentrators. Light and solar energy, 5:23971
Weller, H.R., *See* Roberson, N.R., 5:24912
Wells, J.W., Attrition and elutriation phenomena in industrial atmospheric fluidized bed combustors, 5:23559 (CONF-800545—1)
Wells, K., *See* Nieves, L., 5:24310
Wells, W.M., *See* Walker, J.S., 5:25062
Welsh, L.B., *See* Leyerle, R.W., 5:24241
Wender, S.A., *See* Roberson, N.R., 5:24912
Wentz, D.A., *See* Steele, T.D., 5:24658
Werbeck, R.D., *See* Highland, V.L., 5:24843
Wesely, M.L., *See* Sheih, C.M., 5:24627
West, D., *See* Williams, R.E., 5:23651
West, D.C., *See* Shugart, H.H., 5:24669
Westerberg, A.W., Dynamic and off-design analysis of OTEC closed cycle power systems, 5:23863 (CONF-790631—(Vol.1), pp 8.9.1-8.9.12)
Westphal, W.H., Solution mining of uranium, 5:23699
Westsik, J.H. Jr., *See* Ross, W.A., 5:23738
Wetherell, J.J., Passive solar single family residential project, 5:23900
Whealton, J.H., *See* Menon, M.M., 5:25063
Wheeler, E.M., Potential importance of coal as a feedstock for the US fertilizer industry in the future, 5:23780
Wheelwright, E.J., Kilogram-scale purification of americium by ion exchange, 5:23703 (PNL-SA—7844)
Whitaker, R., How much can we rely on a combined-cycle plant, 5:24013
Whitcomb, C.E., Self-contained solar greenhouse, 5:23893
White, A., Natural Hazards Observer, volume 2, number 4, June 1978, 5:25117 (PB—300976)
White, G.C., Studies of long-term ecological effects of exposure to uranium V, 5:24647 (LA—8221)
White, I.I., Energy from the west: energy resource development systems report. Volume III: oil shale. Final report, 1975-1978, 5:23668 (PB—299179)
White, L.E., Evaluation of a laser-induced fluorescence system for uranium analysis, 5:24491 (Y—2205)
Whitehouse, H., *See* Kast, M., 5:23934
Whitehouse, H.T., IPS system configurations, 5:23939 (SERI/TP—333-429, pp 415-431)
Whitely, J.B., Testing of low Z coated limiters in tokamak fusion devices, 5:25092 (SAND—79-2105C)
Whitham, G.K., *See* Longua, K.J., 5:24063
Whitley, J.B., *See* Langley, R.A., 5:25088
See Mullendore, A.W., 5:25093
Whitlock, R.R., *See* Ripin, B.H., 5:25082
Whitman, R.L., X-ray microradiographs of laser fusion targets: improved image analysis techniques, 5:25079
Whitmore, J.E., *See* Ingalls, R., 5:24465
Whittemore, A.S., Asthma and air pollution in the Los Angeles area. Technical report No. 35, 5:24776 (DOE/EV/02874—69)
Sample size for logistic regression with small response probability. Technical report No. 33, 5:25108 (DOE/EV/02874—64)
Whittemore A.S., Osteosarcomas among beagles exposed to ^{239}Plutonium. Technical report No. 34, 5:24751 (DOE/EV/02874—68)
Whitten, C.A. Jr., *See* Adams, G.S., 5:24911
Wiberg, D.V., Chemical simulation modeling of heat transfer in LMFBRs, 5:24091 (DOE/ET/37205—T1)
See Barker, D.H., 5:24089
Widgoff, M., *See* Brick, D., 5:24854
Widner, M.M., *See* Burns, E.J.T., 5:24481
Wiegand, J., *See* Witkin, R., 5:23981
Wiegand, J.B., Solar radiation collector and water cooler, 5:23967
Wiesmann, H.J., Decomposition of silane on tungsten or other materials, 5:24364
See Strongin, M., 5:24367
Wigh, R.J., Boone County field site interim report. Test cells 2A, 2B, 2C, and 2D. Interim report August 1972-December 1976, 5:24648 (PB—299689)
Wight, L.H., Assessment of effectiveness of geologic isolation systems: the feasibility of computer interrogation of experts for WISAP, 5:23736 (PNL—2862)
Wigton, H.F.H., *See* Lear, D.E. Jr, 5:24021
Wilcke, W.W., Actinide muonic atom lifetimes deduced from muon-induced fission, 5:24937
Wilcox, G.L., *See* McKilligan, K.J., 5:23943
Wild, R.K., *See* Allen, G.C., 5:24419
Wildi, P., Contacts for pulsed high current: design and test, 5:25053
Safety grounding switches in large experiments; general considerations and the TEXT application, 5:25061
Wildung, R.E., *See* Routson, R.C., 5:24645
Wiley, J.C., Steady-state response of the electron distribution function to an applied electric field, 5:25020
Wilgen, J.B., *See* Gilgenbach, R.M., 5:24988
Wilhelmy, J.B., Fission properties of the heavy actinides, 5:24938
See Liesen, D., 5:24827
Wilkening, H.A., Solar industrial process hot water for cement block manufacture, 5:23919 (SERI/TP—333-429, pp 193-197)
Wilkinson, W.O., *See* Rabenhorst, D.W., 5:24099
Willard, H.B., *See* Winkelmann, E., 5:24891
Willard, K.E., Analytical techniques for cell fractions, 5:24674
William, J., *See* Moss, G., 5:24506
Williams, D.E., Weldability of thermally grain-refined Fe-12Ni-0.25Ti for cryogenic structural applications, 5:24369 (LBL—10259)
Williams, F., *See* Boudreaux, D.S., 5:24542
Williams, J.H., *See* Fiore, V.B., 5:23913
Williams, J.I., Deoxyribonucleic acid excision repair in chromatin after ultraviolet irradiation of human fibroblasts in culture, 5:24741
Williams, L.R., *See* Slater, C.O., 5:24059
Williams, M.W., Splitting of surface-plasmon emission spectra from potassium, 5:24412
See Ashley, J.C., 5:24724
Williams, R.A., *See* Orth, C.J., 5:24914
Williams, R.E., Laboratory and fire explosivity testing of oil shale dust, 5:23651
Method for removing suspended oil droplets from water, 5:23587
Williams, S.E., Microbial interactions with aqueous effluents derived from in situ fossil fuel processing, 5:23663
Williamson, P.C., *See* Waitzman, D.A., 5:23787
Willmann, P.A., *See* Boyd, J.K., 5:25018
Wilmoth, R.C., Utilization of fly ash and coal mine refuse as a road base material. Final report 1973-77, 5:24316 (PB—300761)
Wilson, C.J., *See* Kramer, C.M., 5:24458
Wilson, N., *See* Fleet, C., 5:24282
Wilson, N.G., Design and operational characteristics of the cryopump high-vacuum system for the 25 000-l target chamber of the Helios Laser Facility, 5:25096
Wilson, W.B., *See* England, T.R., 5:24047
Wilson, W.E., Calculation of ionization frequency distributions in small sites, 5:24722
Wind, B., *See* Bugg, W.M., 5:24855
Winkelmann, E., Proton-deuteron elastic scattering at 800 MeV, 5:24891
Winkle, S.A., Interactions of 4-nitroquinoline 1-oxide with deoxyribodinucleotides, 5:24679
Winkler, K.A., Formation of solar-type stars in spherical symmetry. I. The key role of the accretion shock, 5:24794
Winograd, N., *See* Holland, S.P., 5:24807
Winston, R., *See* Welford, W.T., 5:23971
Winters, R.R., *See* Johnson, C.H., 5:24902
Wise, J., High statistics measurement of the vector and axial vector coupling constraints in lambda beta decay, 5:24849
Wiser, W.H., Applied research and evaluation of process concepts for liquefaction and gasification of western coals, 5:23444 (FE—2006-17)
Wisniewski, G.R., *See* Dand, P.V., 5:24107
Wiss, J.F., Control of vibration and blast noise from surface coal mining. Volume I. Open file report (final) 1 July 1975-28 February 1978, 5:23519 (PB—299887)
Control of vibration and blast noise from surface coal mining. Volume II. Open file report (final) 1 July 1975-28 February 1978, 5:23520 (PB—299888)
Control of vibration and blast noise from surface coal mining. Volume III. Open file report (final) 1 July 1975-28 February 1978, 5:23521 (PB—299889)
Control of vibration and blast noise from surface coal mining. Volume IV. Executive report. Open file report (final) 1 July 1975-28 February 1978, 5:23522 (PB—299890)
Witkin, R., Operations research for geothermal development in California and Hawaii, 5:23981
Wittberg, T.N., *See* Moddeman, W.E., 5:24580
Wittenberg, L.J., Evaluation of solar pond performance, 5:23953 (MLM—2702(OP))
Witzke, H., *See* Chen, S., 5:23845
Wolf, A.P., *See* Schlyer, D.J., 5:23452
Wolfenstein, L., Gauge models of CP violation, 5:24873
Wolfsberg, K., *See* Orth, C.J., 5:24899
Wolfson, J., *See* Brick, D., 5:24854

Wollersheim, H.J., *See* Liesen, D., 5:24827
Wolsko, T.D., *See* Newsom, D.E., 5:23848
Wong, B., *See* Garcia, A., 5:23811
Wong, C., *See* Tang, H.H.K., 5:24928
Wong, K.L., Current generation by unidirectional lower hybrid waves in the ACT-1 toroidal device, 5:25003 (PPPL—1662)
Wong, P., Characterization of aged unactivated thermal battery components, 5:24126
Wood, C.D., Control technology for diesel equipment in the underground mining environment - a review of selected topics. Final report 23 August 1978-31 January 1979, 5:24520 (PB—299946)
Wood, D.E., What is risk assessment, 5:23757 (RHO-SA—165)
Wood, J.L., Use of systematics in the interpretation of nuclear structure far from the beta-stable region, 5:24930 (CONF-790976—9)
See Braendlein, R.K., 5:24339
Wood, P.J., Air pressure differential energy system, 5:24014
See Hammelman, J.E., 5:24543
Wood, R.F., *See* Kirkpatrick, J.R., 5:24368
Woodall, D.M., *See* Humphries, S. Jr., 5:24550
Woodson, H.H., *See* Bullion, T.M., 5:25059
See Gully, J.H., 5:25057
See Mayhall, D.J.T., 5:25058
Woodworth, L.M., R and D activities in pulse combustion at BNL, 5:24248 (BNL—27602)
Worthington, R.B., *See* Paulson, D.L., 5:23514
Wrathall, J., *See* Ergun, S., 5:23836
Wrenn, M.E., *See* Cohen, N., 5:24752, 5:24755, 5:24758
See Lipsztein, J., 5:24753
See Neton, J., 5:24759, 5:24760
See Sasso, T.L., 5:24756, 5:24757
Wriekat, A., *See* Adams, G.S., 5:24911
Wright, A.L., ORNL experiments to characterize fuel release from the reactor primary containment in severe LMFBR accidents, 5:24086 (CONF-800434—2)
Wright, B.L., *See* Massey, R.S., 5:25013
Wright, B.R., *See* Fodor, G.E., 5:23599
Wright, E.A., *See* Tippets, F.E., 5:24056
Wright, P.J., Lime/fly ash injection applications, 5:23508 (METC/SP—79/10(Pt.2), pp 904-910)
Wright, R.E., 1000-kVA arc power supply, 5:25052 (CONF-791102—166)
Wright, R.R., Pre-treatment for molybdenum or molybdenum-rich alloy articles to be plated, 5:24366
Wronski, C.R., *See* Staebler, D.L., 5:24467
Wu, W., Indexing of diffracting planes using the Kikuchi pattern, 5:24384
Wyatt, J.M., Treatment of waste water effluents from coal gasification units, 5:23434
Wyeth, N.C., Barrier heights of evaporated metal contacts on Zn_3P_2, 5:24474

Y

Yaffe, P.L., Examination of the effects of 50 ppB copper on the black abalone, Haliotis cracherodii, 5:24770 (UCRL—52932)
Yaghoubzadeh, N., *See* Ergun, S., 5:23836
Yalamanchi, B., *See* Motowidlo, L., 5:24403
Yamamoto, R.K., *See* Brick, D., 5:24854
Yamauchi, T., *See* Giori, C., 5:23450
Yamin, H., *See* Peled, E., 5:24170
Yan, T.Y., Method of stabilizing lube oils, 5:23597
Yang, C.W., Quadratic programming and spatial equilibrium: the case of coal. Program working papers, 5:23566 (PB—301365)
Yang, H.T., *See* Zehr, S.W., 5:23818
Yang, J.J.J., *See* Manasevit, H.M., 5:23804
See Ruth, R.P., 5:23808
Yang, S.N., *See* Thornton, S.I., 5:23499
Yao, N.P., *See* Loutfy, R.O., 5:24361
Yao, S., *See* Westerberg, A.W., 5:23863
Yarmonenko, S.P., *See* Voloshina, E.A., 5:24747
Yasuda, A.K., Application of solar energy for the generation and supply of industrial process low to intermediate pressure steam ranging in temperature from 300°F to 550°F, 5:23929 (SERI/TP—333-429, pp 267-272)
Yates, S.W., High-spin properties of ^{164}Er in the multiple band crossing region, 5:24922
Yeh, J.J., *See* Zubairy, M.S., 5:24830
Yerkes, J.W., *See* Davis, R.R., 5:23826
Ying, S.P., Use of acoustic emission for assessing the integrity of a nuclear reactor pressure vessel, 5:24392
Yokoyama, K., *See* Uetani, Y., 5:24118
Yonei, S., Evidence for a change in the fluidity of erythrocyte membranes following x irradiation by measurement of pyrene excimer fluorescence, 5:24738
Yoo, H.I., Silicon solar cell process development, fabrication and analysis. Fifth quarterly report, October 1, 1979-December 31, 1979, 5:23813 (DOE/JPL/955089—80/6)
York, T.M., *See* Jacoby, B.A., 5:24998
Yoshimura, H.R., *See* Rack, H.J., 5:24519
Young, B., *See* Hwang, H.H., 5:24039
Young, C., Spent shale compaction for void volume generation in in situ oil shale processing, 5:23638
Young, F.C., Absolute calibration of a prompt gamma ray detector for intense bursts of protons, 5:24563 (NRL-MR—4171)
See Ripin, B.H., 5:25082
Young, M., *See* Schultz, H.W., 5:24327
Young, N.B., *See* Smith, J.W., 5:23635
Young, R.W., *See* Cowan, M.J., 5:23655
Youngblood, S.B., Solar production of industrial process steam, 5:23926 (SERI/TP—333-429, pp 251-256)
Yu, L.C., *See* Lebo, R.V., 5:24711
Yuhas, D., *See* Kupperman, D.S., 5:24507
Yurkovac, F., *See* Levy, A., 5:24256

Z

Zabinski, R.J., Impact of air quality control measures, 5:24640 (PB—301234)
Zaccone, H., *See* Himel, T.M., 5:24840
Zafiratos, C.D., *See* Alford, W.P., 5:24918
Zakharenko, I.D., Viscosity of metals in explosive welding, 5:24371 (UCRL-Trans—11542)
Zborovsky, Z., *See* Williams, R.E., 5:23651
Zdanis, R., *See* Brick, D., 5:24854
Zee, A., Horizon problem and the broken-symmetric theory of gravity, 5:24799
Zehner, D.M., *See* Davis, H.L., 5:24379
Zehr, S.W., Advanced photovoltaic concentrator cells. Quarterly technical progress report No. 1, August 28, 1979-November 30, 1979, 5:23818 (DSE—4042-T30)
Zeldin, A., High temperature concrete composites containing organosiloxane crosslinked copolymers, 5:24439
Polymer concrete composites for the production of high strength pipe and linings in high temperature corrosive environments, 5:24444
Zeman, O., Dynamics and modeling of heavier-than-air, cold gas releases, 5:23612 (UCRL—15224)
Zhurkin, V.V., Asymmetry in total scattering of polarized protons by nuclei at 2.1 GeV/s, 5:24839 (LA-tr—80-12)
Zisman, M.S., Dominance of strong absorption in $^{9}Be + ^{28}Si$ elastic scattering, 5:24903
Zook, J.D., *See* Seager, C.H., 5:23822
Zoschak, R.J., *See* Sommerlad, R.E., 5:23917
Zowarka, R., *See* Bullion, T.M., 5:25059
Zowarka, R.C., *See* Gully, J.H., 5:25057
Zubairy, M.S., Photon statistics in multiphoton absorption and emission processes, 5:24830

SUBJECT INDEX

The subject index is based on the use of subject descriptors selected from a controlled thesaurus of terms. Subject descriptors and qualifiers (subheadings) are selected and presented in the following format:

SUBJECT DESCRIPTOR/QUALIFIER
Title, (supplementary information), citation number, (report number)

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed.

A

ABSORPTION REFRIGERATION CYCLE/RESEARCH PROGRAMS
Development of solar driven absorption air conditioners and heat pumps, 5:23888 (LBL—10771)
Overview-absorption/Rankine solar cooling program, 5:23887 (LBL—10770)

ACCELERATOR FACILITIES/PERSONNEL MONITORING
Radiation monitoring. Lecture 26, course on advances in radiation: International School of Radiation Damage and Protection, Erice, Italy, September 1979, 5:24631 (LBL—9814)

ACCELERATOR FACILITIES/RADIATION MONITORING
Radiation monitoring. Lecture 26, course on advances in radiation: International School of Radiation Damage and Protection, Erice, Italy, September 1979, 5:24631 (LBL—9814)

ACCRETION (STARS)
See STAR ACCRETION

ACETIC ACID/ADSORPTION
Low energy electron diffraction (LEED) study of the adsorption of acetic acid and propanoic acid on Ag(111) and Pt(111), 5:24406

ACETIC ACID ESTERS/CHEMICAL PREPARATION
Heat and chemically resistant membranes, 5:24166

ACETONE/ISOTOPE EFFECTS
Critical test of vibrational dephasing theories in liquids by use of selective, coherent, picosecond Stokes scattering, 5:24476

ACID ELECTROLYTE FUEL CELLS/ELECTROCATALYSTS
New H_3PO_4 fuel cell electrocatalysts made from alumina/pyropolymer composites, 5:24241

ACID MINE DRAINAGE/WASTE PROCESSING
Treatment categories for coal mine drainage. Final report January 1978-January 1979, 5:24617 (PB—301065)

ACID RAIN/ENVIRONMENTAL EFFECTS
Regional ecological assessment approach to atmospheric deposition: effects on soil systems (Sensitivity of soils in eastern US to acid rain), 5:24643 (CONF-791090—7)

ACRIDINE ORANGE/MUTAGENESIS
Photodynamic effects of dyes on bacteria. I. Mutagenesis by acridine orange in the dark in excision- and recombination-deficient strains of Escherichia coli, 5:24766

ACRYLATES/CHARGED-PARTICLE TRANSPORT
Experimental limits on deviations from Z^2 dependence of Cerenkov radiation by heavy ions, 5:24950

ACRYLIC ACID ESTERS/CHEMICAL RADIATION EFFECTS
process for coating a substrate with a radiation and moisture curable coating composition (Patent), 5:24503

ACTIN/BIOASSAY
Biochemical studies of mouse brain tubulin: colchicine binding (DEAE-cellulose filter) assay and subunits (α and β) biosynthesis and degradation (in newborn brain), 5:24695 (UR—3490-1559)

ACTIN/BIOSYNTHESIS
Biochemical studies of mouse brain tubulin: colchicine binding (DEAE-cellulose filter) assay and subunits (α and β) biosynthesis and degradation (in newborn brain), 5:24695 (UR—3490-1559)

ACTIN/CATABOLISM
Biochemical studies of mouse brain tubulin: colchicine binding (DEAE-cellulose filter) assay and subunits (α and β) biosynthesis and degradation (in newborn brain), 5:24695 (UR—3490-1559)

ACTIN/ELECTROPHORESIS
Muscle protein analysis. I. High-resolution two-dimensional electrophoresis of skeletal muscle proteins for analysis of small biopsy samples, 5:24676

ACTINIDES/CATALYTIC EFFECTS
Catalyst for synthesis of methanol (Patent), 5:23774

ACTINIDES/SEPARATION PROCESSES
Methods for separating actinides from reprocessing and refabrication plant wastes, 5:23715 (CONF-791112—63)

ACTINIUM 230/BETA-MINUS DECAY
Levels of ^{230}Ac and ^{230}Th populated by decay of ^{230}Ra and ^{230}Ac, 5:24935

ACTINIUM 230/ENERGY LEVELS
Levels of ^{230}Ac and ^{230}Th populated by decay of ^{230}Ra and ^{230}Ac, 5:24935

ACTINIUM 230/ENERGY-LEVEL TRANSITIONS
Levels of ^{230}Ac and ^{230}Th populated by decay of ^{230}Ra and ^{230}Ac, 5:24935

ACTINOMYCIN/PHARMACOLOGY
Actinomycin D-deoxynucleotide interactions: binding isotherms at the benzenoid and quinoid portions of the drug, 5:24692

ACTIVATION DETECTORS/ACCURACY
Relating surveillance capsule measurements to pressure vessel damage, 5:24073 (BNL-NUREG—27192)

ADENOCARCINOMAS
See CARCINOMAS

ADENOMAS/RADIOINDUCTION
Synergism of diethylstilbestrol and radiation in mammary carcinogenesis in female F344 rats, 5:24749

ADENOSINE MONOPHOSPHATE
See AMP

ADENOSINE TRIPHOSPHATE
See ATP

ADENOVIRUS/SARCOMAS
Is the product of the src gene a promoter, 5:24714

ADRENAL GLANDS/SENSITIVITY
Pituitary-adrenal response in neonatal rats, 5:24716

ADVANCED GAS COOLED GRAPHITE REACTOR
See AGR TYPE REACTORS
AEROSOL MONITORING/QUALITY CONTROL
Haos quality assurance final report: criteria pollutants. Volume I. Final report, 5:24600 (PB—299639)
HAOS quality assurance final report: non-criteria pollutants. Volume II. Final report, 5:24601 (PB—299640)
AEROSOLS
See also RADIOACTIVE AEROSOLS
AEROSOLS/CHEMICAL COMPOSITION
Detailed characterization of gaseous and size-resolved particulate pollutants at a south coast air basin smog receptor site: levels and modes of formation of sulfate, nitrate and organic particulates and their implications for control strategies. Final report November 1975-June 1978, 5:24620 (PB—301294)
AEROSOLS/CORROSIVE EFFECTS
Smoke and corrosivity, 5:24452 (EPRI-EL—1263)
AEROSOLS/ENVIRONMENTAL IMPACTS
Aerosols and climate, 5:24589 (CONF-800309—5)
AEROSOLS/PARTICLE SIZE
Impact of gaseous sulfur and aerosols produced by power plants on the CCN budget. Progress report, September 1, 1978-August 31, 1979, 5:24590 (COO—4965-1)
AEROSPACE INDUSTRY/FUEL ECONOMY
Opportunities in Canadian transportation, 5:24265
AEROSPACE INDUSTRY/MANAGEMENT
Opportunities in Canadian transportation, 5:24265
AFR STORAGE
See AWAY-FROM-REACTOR STORAGE
AFTER-HEAT
Fission product decay heat for thermal reactors, 5:24084 (CONF-791058—71)
AGED
See ELDERLY PEOPLE
AGGLUTININS/BIOLOGICAL EFFECTS
Inhibition of cytotoxic T lymphocytes with concanavalin A, 5:24703
AGR TYPE REACTORS/REACTOR MATERIALS
Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, October 1, 1979-December 31, 1979, 5:24049 (COO—2975-40)
AGRICULTURAL WASTES
See also MANURES
AGRICULTURAL WASTES/ANAEROBIC DIGESTION
Iowa solar applications: holding at the do-it-yourself level, 5:23873
AGRICULTURAL WASTES/COMBUSTION
Hydrocarbon characterization of agricultural waste burning. Final report, 5:24615 (PB—300916)
AGRICULTURAL WASTES/MANAGEMENT
Grain-dust pelleting costs and capital requirements for stationary and portable plants, 5:23793 (PB—300690)
AGRICULTURE
See also FARMS
AGRICULTURE/ECONOMIC IMPACT
Agricultural sector impacts of making ethanol from grain, 5:23776 (SERI/TR—352-554)
AIR CLEANING SYSTEMS/HEALTH HAZARDS
Impact of reduced infiltration and ventilation on indoor air quality, 5:24624
AIR FILTERS/PERFORMANCE TESTING
Diesel hydrocarbon measurement - series filter test. Technical report, 5:24356 (PB—301410)
AIR HEATERS
See also SOLAR AIR HEATERS
AIR HEATERS/MATHEMATICAL MODELS
MHD component and system modeling, 5:24219 (FE—2215-13(Vol.2))
AIR POLLUTION
See also INDOOR AIR POLLUTION
STATIONARY POLLUTANT SOURCES
AIR POLLUTION/AEROSOL MONITORING
Study of the nature of ozone, oxides of nitrogen, and nonmethane hydrocarbons in Tulsa, Oklahoma. Volume I. project description and data summaries, 5:24614 (PB—300481)
AIR POLLUTION/BIBLIOGRAPHIES
Nitrogen oxide air pollution. Part 5. Emissions studies. Volume 2. 1975-1977 (a bibliography with abstracts). Report for 1975-77, 5:24597 (NTIS/PS—79/1061)
Nitrogen oxide air pollution. Part 5. Emissions studies. Volume 3. 1978-August, 1979 (a bibliography with abstracts). Report for 1975-August 1979, 5:24598 (NTIS/PS—79/1062)
AIR POLLUTION/CORRELATIONS
Asthma and air pollution in the Los Angeles area. Technical report No. 35, 5:24776 (DOE/EV/02874—69)
AIR POLLUTION/DAILY VARIATIONS
Weekend/weekday differences in oxidants and their precursors. Final report, 5:24613 (PB—300479)
AIR POLLUTION/DATA ACQUISITION
Asthma and air pollution in the Los Angeles area. Technical report No. 35, 5:24776 (DOE/EV/02874—69)
AIR POLLUTION/INFORMATION
Development of questionnaires for various emission inventory uses. Final report, 5:24587 (PB—300384)
AIR POLLUTION/MATHEMATICAL MODELS
A lagrangian photochemical air quality simulation model: adaptation to the St. Louis - Raps Data Base. Volume I. Model formulation. Final report, 5:24611 (PB—300470)
A lagrangian photochemical air quality simulation model: adaptation to the St. Louis - Raps Data Base. Volume II. User's manual. Final report, 5:24612 (PB—300471)
AIR POLLUTION/SAMPLING
Air quality data for nonmetallic inorganic ions: NH4+, NO3-, SO4= from the National Air Surveillance Networks, 1976. Final report, 5:24610 (PB—300458)
AIR POLLUTION/STANDARDIZED TERMINOLOGY
Epa chemical activities status report, first edition, 5:24621 (PB—301366)
AIR POLLUTION/STRATOSPHERE
Report on the progress of regulations to protect stratospheric ozone. Annual report 1978-79, 5:24622 (PB—301368)
AIR POLLUTION ABATEMENT/COST
The cost of clean air and water. Report to Congress, 5:24637 (PB—300446)
AIR POLLUTION CONTROL/ECONOMIC IMPACT
Balancing the objectives of clean air and economic growth: regulated markets in emission reductions. Interim report, 5:24639 (PB—300835)
AIR POLLUTION CONTROL/PLANNING
Transortation Control Plan. Volume 3: Technical Documentation (Plan for control of traffic-related air pollution in Baltimore metropolitan area through 1987), 5:24599 (PB—297525)
AIR POLLUTION CONTROL/REGULATIONS
A review of standards of performance for new stationary sources - petroleum refineries, 5:24638 (PB—300480)
AIR POLLUTION MONITORS
Continuous air pollution source monitoring systems, 5:24616 (PB—300930)
AIR POLLUTION MONITORS/COMPARATIVE EVALUATIONS
Formaldehyde monitoring program: development of sampling and analysis procedures. Report to the Consumer Product Sampling Commission, 5:24592 (DOE/TIC—11203)
AIR POLLUTION MONITORS/DESIGN
Chemiluminescent process and detector for monitoring atmospheric contaminants (Patent), 5:24625
Vapor emission recovery and measuring method and vapor recovery collection boot (Patent), 5:24626
AIR QUALITY/DAILY VARIATIONS
Weekend/weekday differences in oxidants and their precursors. Final report, 5:24613 (PB—300479)
AIR QUALITY/SIMULATION
A lagrangian photochemical air quality simulation model: adaptation to the St. Louis - Raps Data Base. Volume I. Model formulation. Final report, 5:24611 (PB—300470)
AIRCRAFT/ACCIDENTS
Aircraft accident report - Champion Home Builders Company, Gates Learjet 25B, N999HG, Sanford, North Carolina, September 8, 1977, 5:24123 (NTISUB/E—104-015)
AIRCRAFT/ELECTRIC BATTERIES
Batteries for auxiliary electrical supplies in aircraft, 5:24172
AIRCRAFT/FIRES
Aircraft accident report - Champion Home Builders Company, Gates Learjet 25B, N999HG, Sanford, North Carolina, September 8, 1977, 5:24123 (NTISUB/E—104-015)
AIRCRAFT/NICKEL-ZINC BATTERIES
Development of nickel-zinc batteries for aircraft, remotely piloted vehicle and missile applications, 5:24137
AIRCRAFT FUELS
See AVIATION FUELS
ALABAMA/ELECTRIC UTILITIES
Analysis of environmental factors affecting technology deployment: a case study, 5:24027 (DOE/RA/10001—T1)
ALABAMA/MAGNETIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
Aerial radiometric and magnetic survey: Phenix City National Topographic Map, Alabama/Georgia, Southeast US Project 1979, 5:23691 (GJBX—101(80))
ALABAMA/RADIOMETRIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia.

Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
Aerial radiometric and magnetic survey: Phenix City National Topographic Map, Alabama/Georgia, Southeast US Project 1979, 5:23691 (GJBX—101(80))
ALANINES/METABOLISM
Effects of ethanol on alanine metabolism in perfused mouse liver studied by ^{13}C NMR, 5:24717
ALAP
See RADIATION PROTECTION
ALARA
See RADIATION PROTECTION
ALASKA/ECONOMIC DEVELOPMENT
Jobs and power for Alaskans - a program for power and economic development, 5:24178 (PB—299729)
ALASKA/EMPLOYMENT
Jobs and power for Alaskans - a program for power and economic development, 5:24178 (PB—299729)
ALASKA/ENERGY SOURCE DEVELOPMENT
Jobs and power for Alaskans - a program for power and economic development, 5:24178 (PB—299729)
ALASKA/FUEL CONSUMPTION
Historic and projected oil and gas consumption, 5:23605
ALASKA/GEOCHEMICAL SURVEYS
Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States, 5:23697 (LA-UR—80-1013)
ALASKA/HUMAN POPULATIONS
Anaktuvuk Pass, Alaska village census, 5:24668 (PNL—3081)
ALASKA/MAGNETIC SURVEYS
Airborne gamma-ray spectrometer and magnetometer survey: Nulato quadrangle (Alaska). Final report, 5:23677 (GJBX—73(80)(Vol.1))
Airborne gamma-ray spectrometer and magnetometer survey: Nulato quadrangle (Alaska). Final report, 5:23678 (GJBX—73(80)(Vol.2))
Airborne gamma-ray spectrometer and magnetometer survey: Sleetmute quadrangle (Alaska). Final report, 5:23679 (GJBX—79(80)(Vol.1))
Airborne gamma-ray spectrometer and magnetometer survey: Sleetmute quadrangle (Alaska). Final report, 5:23680 (GJBX—79(80)(Vol.2))
Airborne gamma-ray spectrometer and magnetometer survey: Iditarod quadrangle (Alaska). Final report, 5:23681 (GJBX—80-(80)(Vol.1))
ALASKA/POWER GENERATION
Jobs and power for Alaskans - a program for power and economic development, 5:24178 (PB—299729)
ALASKA/RADIOMETRIC SURVEYS
Airborne gamma-ray spectrometer and magnetometer survey: Nulato quadrangle (Alaska). Final report, 5:23677 (GJBX—73(80)(Vol.1))
Airborne gamma-ray spectrometer and magnetometer survey: Nulato quadrangle (Alaska). Final report, 5:23678 (GJBX—73(80)(Vol.2))
Airborne gamma-ray spectrometer and magnetometer survey: Sleetmute quadrangle (Alaska). Final report, 5:23679 (GJBX—79(80)(Vol.1))
Airborne gamma-ray spectrometer and magnetometer survey: Sleetmute quadrangle (Alaska). Final report, 5:23680 (GJBX—79(80)(Vol.2))
Airborne gamma-ray spectrometer and magnetometer survey: Iditarod quadrangle (Alaska). Final report, 5:23681 (GJBX—80-(80)(Vol.1))
ALCATOR DEVICE/DESORPTION
Thermal desorption measurements of hydrogen—isotope retention in the Alcator-A tokamak, 5:25101
ALCATOR DEVICE/PLASMA DIAGNOSTICS
Soft x-ray imaging instrument for the Alcator A tokamak, 5:24999
ALCOHOL FUEL CELLS/ANODES
Fuel cell anode electrode, method of making the fuel cell anode electrode, and fuel cell containing the fuel cell anode electrode (Patent), 5:24240
ALCOHOL FUEL CELLS/DESIGN
1.5-kW methanol fuel cell power plant system design study, 5:24236
1 kW tungsten carbide fuel cell power plant with a methanol cracker, 5:24235
ALCOHOL FUEL CELLS/FUEL SYSTEMS
1 kW tungsten carbide fuel cell power plant with a methanol cracker, 5:24235
ALCOHOL FUELS/FINANCIAL INCENTIVES
National Fuel Alcohol and Farm Commodity Production Act of 1979. Hearings before the Committee on Agriculture, Nutrition, and Forestry, United States Senate, Ninety-Sixth Congress, First Sesson on S. 850, July 17 and 19, 1979, 5:23842
ALCOHOL FUELS/HEARINGS
National Fuel Alcohol and Farm Commodity Production Act of 1979. Hearings before the Committee on Agriculture, Nutrition, and Forestry, United States Senate, Ninety-Sixth Congress, First Sesson on S. 850, July 17 and 19, 1979, 5:23842
ALFVEN WAVES/KINETIC EQUATIONS
Kinetic properties of Alfven waves, 5:25035
ALFVEN WAVES/STABILITY
Stability of shear flow in a magnetized plasma, 5:25021
ALGAE/NITROGEN FIXATION
Nitrogen fixation in Clear Lake, California. 4. Diel studies on Aphanizomenon and Anabaena blooms, 5:24689
ALKALI METAL COMPOUNDS/CRYSTAL DOPING
Observation of resonantly enhanced degenerate four-wave mixing in doped alkali halides, 5:24475
ALKALI METAL COMPOUNDS/OPTICAL PROPERTIES
Observation of resonantly enhanced degenerate four-wave mixing in doped alkali halides, 5:24475
ALKENOIC ACIDS
See CARBOXYLIC ACIDS
ALLOY 800
See INCOLOY 800
ALLOY-HD-8077
See NICKEL BASE ALLOYS
ALLOY-MA-754
See NICKEL BASE ALLOYS
ALLOY-MM-0011
See IRON BASE ALLOYS
ALLOYS/ELECTRONIC STRUCTURE
Calculating properties with the coherent-potential approximation, 5:24958
ALLOYS/ION IMPLANTATION
Properties and applications of ion-implanted alloys, 5:24410
ALLOYS/ULTRALOW TEMPERATURE
Properties and applications of ion-implanted alloys, 5:24410
ALLOY-WAZ-16
See NICKEL BASE ALLOYS
ALPHA DETECTION/LIQUID SCINTILLATION DETECTORS
Alpha liquid scintillation counting: past, present, and future, 5:24560 (CONF-790859—3)
New advanced in alpha spectrometry by liquid scintillation methods, 5:24559 (CONF-791117—26)
ALPHA REACTIONS/COMPOUND-NUCLEUS REACTIONS
High-spin properties of ^{164}Er in the multiple band crossing region, 5:24922
ALPHA REACTIONS/STRIPPING
Description of direct nuclear rearrangement reactions using various coupled channel equations, 5:24946
ALPHA SPECTROMETERS/ALPHA SPECTRA
New advanced in alpha spectrometry by liquid scintillation methods, 5:24559 (CONF-791117—26)
ALTERNATE FUELS
See FUEL SUBSTITUTION
SYNTHETIC FUELS
ALUMINA
See ALUMINIUM OXIDES
ALUMINATES/CORROSION
Refractory materials for coal fueled mhd power generation. Final report, 5:24436 (PB—301095)
ALUMINATES/FABRICATION
Advanced fuel cell development. Progress report, July-September 1979 (Molten carbonate fuel cells), 5:24233 (ANL—79-110)
Advanced fuel cell development. Progress report, April-June 1979 (Molten carbonate fuel cells), 5:24232 (ANL—79-84)
ALUMINATES/PHYSICAL PROPERTIES
Advanced fuel cell development. Progress report, April-June 1979 (Molten carbonate fuel cells), 5:24232 (ANL—79-84)
ALUMINIUM
Effect of container preparation on the growth of protium and methane impurities into tritium gas, 5:25095
ALUMINIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
ALUMINIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
ALUMINIUM/BONDING
Bonding of Al and Ga to GaAs(110), 5:24381
ALUMINIUM/COMPATIBILITY
Reliability and durability study of a thermal receiver utilizing ASI Type 316 stainless steel in contact with molten aluminum, 5:23860 (SERI/TP—641-653)
ALUMINIUM/DENSITY
Extension of liquid-metal theory to dense partially ionized plasmas, 5:24834
ALUMINIUM/EXPLOSION WELDING
Viscosity of metals in explosive welding, 5:24371 (UCRL-Trans—11542)

ALUMINIUM/IGNITION
Role of surface chemistry in the ignition of pyrotechnic materials, 5:24580 (MLM—2708(OP))
ALUMINIUM/INTERFACES
Bonding of Al and Ga to GaAs(110), 5:24381
ALUMINIUM/ION COLLISIONS
Auger spectra induced by 100-keV Ar^+ impact on Be, Al, and Si, 5:24806
ALUMINIUM/MATERIALS RECOVERY
A pollution-free system for the economic utilization of municipal solid waste, task 10, electrochemical recovery of non ferrous metals derived from municipal refuse, 5:24326 (PB—299753)
Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation. Volume II. working papers, 5:24329 (PB—300848)
Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation, 5:24330 (PB—300849)
ALUMINIUM/PHOTOELECTRON SPECTROSCOPY
Enhanced photoexcitation from the surface of aluminum, 5:24409
ALUMINIUM/PHOTOIONIZATION
Enhanced photoexcitation from the surface of aluminum, 5:24409
ALUMINIUM/PHYSICAL RADIATION EFFECTS
Post irradiation dose determination of 800 MeV proton irradiated aluminum from LAMPF experiment 407, 5:24422 (LA—8351-MS)
X-ray induced auger electron spectroscopic studies on aluminum metal surface films in aluminum/iron oxide thermites, 5:24437 (MLM—2711(OP))
ALUMINIUM/PRODUCTION
Method of winning aluminum metal from aluminous ore (Patent), 5:24361
ALUMINIUM/PROTON REACTIONS
Asymmetry in total scattering of polarized protons by nuclei at 2.1 GeV/s, 5:24839 (LA-tr—80-12)
ALUMINIUM/RADIOCHEMICAL ANALYSIS
Post irradiation dose determination of 800 MeV proton irradiated aluminum from LAMPF experiment 407, 5:24422 (LA—8351-MS)
ALUMINIUM/THERMODYNAMIC PROPERTIES
Extension of liquid-metal theory to dense partiaily ionized plasmas, 5:24834
ALUMINIUM/VAPOR DEPOSITED COATINGS
Quantitative characterization of high strength aluminum foils vapor deposited on curved surfaces, 5:24380
ALUMINIUM 27 REACTIONS/COMPOUND-NUCLEUS REACTIONS
Backward angle cross sections for $^{27}Al + ^{16}O$ reaction products, 5:24898
ALUMINIUM 27 REACTIONS/DEEP INELASTIC HEAVY ION REACTIONS
Backward angle cross sections for $^{27}Al + ^{16}O$ reaction products, 5:24898
ALUMINIUM 27 TARGET/NITROGEN 15 REACTIONS
Complete fusion of $^{15}N + ^{27}Al$, 5:24906
ALUMINIUM 27 TARGET/PION MINUS REACTIONS
Interpretation of quasielastic pion scattering coincidence experiments, 5:24893
ALUMINIUM 27 TARGET/PION PLUS REACTIONS
Interpretation of quasielastic pion scattering coincidence experiments, 5:24893
ALUMINIUM ALLOYS/DECOMPOSITION
Self-disintegrating raney metal alloys (Patent), 5:24370
ALUMINIUM ALLOYS/FABRICATION
Alloys for a liquid metal fast breeder reactor (Patent), 5:24372
Self-disintegrating raney metal alloys (Patent), 5:24370
ALUMINIUM ALLOYS/FLEXIBILITY
Method of manufacturing a niobium-aluminum-germanium superconductive material (Patent), 5:24362
ALUMINIUM ALLOYS/PHYSICAL RADIATION EFFECTS
Relationship between swelling and the shear modulus of irradiated metal, 5:24421 (HEDL-SA—1774-FP)
ALUMINIUM ALLOYS/SURFACE COATING
Method of manufacturing a niobium-aluminum-germanium superconductive material (Patent), 5:24362
ALUMINIUM ALLOYS/SWELLING
Relationship between swelling and the shear modulus of irradiated metal, 5:24421 (HEDL-SA—1774-FP)
ALUMINIUM CHLORIDES/SURFACE COATING
Chemical vapor deposition of sialon (Patent), 5:24425
ALUMINIUM OXIDES/CORROSION
Refractory materials for coal fueled mhd power generation. Final report, 5:24436 (PB—301095)
ALUMINIUM OXIDES/ELECTRIC CONDUCTIVITY
Electrode module materials evaluation, 5:24223 (FE—2215-13(Vol.1))
Radiation-induced conductivity of Al_2O_3: Experiment and theory, 5:24438
ALUMINIUM OXIDES/FABRICATION
Research on electrodes and electrolyte for the Ford sodium-sulfur battery. Annual report 30 June 1976-31 October 1977, 5:24428 (PB—301409)
ALUMINIUM OXIDES/HOT PRESSING
X-ray induced auger electron spectroscopic studies on aluminum metal surface films in aluminum/iron oxide thermites, 5:24437 (MLM—2711(OP))
ALUMINIUM OXIDES/PHASE DIAGRAMS
Electrode module materials evaluation, 5:24223 (FE—2215-13(Vol.1))
ALUMINIUM OXIDES/PHYSICAL RADIATION EFFECTS
Radiation-induced conductivity of Al_2O_3: Experiment and theory, 5:24438
X-ray induced auger electron spectroscopic studies on aluminum metal surface films in aluminum/iron oxide thermites, 5:24437 (MLM—2711(OP))
ALUMINIUM OXIDES/PRODUCTION
Glass-ceramics for lightning arrestor connector seals, 5:24429 (SAND—80-0215)
ALUMINIUM OXIDES/RECOVERY
New developments in the lime-soda sinter process for recovery of alumina from fly ash, 5:23466 (METC/SP—79/10(Pt.1))
ALUMINIUM OXIDES/SURFACE COATING
X-ray induced auger electron spectroscopic studies on aluminum metal surface films in aluminum/iron oxide thermites, 5:24437 (MLM—2711(OP))
ALUMINIUM OXIDES/VAPOR DEPOSITED COATINGS
Quantitative characterization of high strength aluminum foils vapor deposited on curved surfaces, 5:24380
ALUMINIUM SULFIDES/PRODUCTION
Method of winning aluminum metal from aluminous ore (Patent), 5:24361
ALUMINIUM-AIR BATTERIES/CATHODES
Energy savings by means of fuel cell electrodes in electro-chemical industries. Progress report, August 1-October 31, 1978, 5:24498 (COO—4881-3)
ALUMINIUM-AIR BATTERIES/MATERIALS
Control system considerations for an aluminum-air battery powered electric vehicle. Final report, 5:24348 (UCRL—15241)
ALUMINIUM-AIR BATTERIES/PERFORMANCE
Energy savings by means of fuel cell electrodes in electro-chemical industries. Progress report, August 1-October 31, 1978, 5:24498 (COO—4881-3)
ALUMINIUM-AIR BATTERIES/SPECIFICATIONS
Control system considerations for an aluminum-air battery powered electric vehicle. Final report, 5:24348 (UCRL—15241)
AMERICAN INDIANS/HUMAN POPULATIONS
Anaktuvuk Pass, Alaska village census, 5:24668 (PNL—3081)
AMERICIUM/ION EXCHANGE
Kilogram-scale purification of americium by ion exchange, 5:23703 (PNL-SA—7844)
AMERICIUM 241/INHALATION
Metabolism of americium-241 in man: an unusual case of internal contamination of a child and his father, 5:24752 (COO—3382-18)
AMERICIUM 241/METABOLISM
Metabolism of americium-241 in man: an unusual case of internal contamination of a child and his father, 5:24752 (COO—3382-18)
Radioactivity studies progress report (Lead abstract), 5:24755 (COO—3382-18)
AMERICIUM 241/PURIFICATION
Kilogram-scale purification of americium by ion exchange, 5:23703 (PNL-SA—7844)
AMERICIUM 241/TISSUE DISTRIBUTION
Radioactivity studies progress report (Lead abstract), 5:24755 (COO—3382-18)
AMERICIUM 243/PURIFICATION
Kilogram-scale purification of americium by ion exchange, 5:23703 (PNL-SA—7844)
AMERICIUM BASE ALLOYS/CRYSTAL STRUCTURE
High-pressure phase in americium metal, 5:24377
AMES TEST
See MUTAGEN SCREENING
AMMONIA/ECONOMICS
Ammonia from coal, 5:23778
Future ammonia business: market and economic considerations (Forecasting), 5:23791
Future availability of feedstocks for ammonia production (To 2000), 5:23781
AMMONIA/MARKET
Future ammonia business: market and economic considerations (Forecasting), 5:23791
AMMONIA/MEETINGS
Ammonia from coal, 5:23778
AMMONIA/PRODUCTION
Ammonia from coal, 5:23778

Carbon monoxide shift catalysts and carbonyl sulfide hydrolysis catalysts, 5:23435
Coal-based ammonia plants: preliminary operating experience of coal gasification at Talcher and Ramagundam fertilizer plants of The Fertilizer Corporation of India, 5:23788
Coal technology for ammonia production, 5:23787
Current status of the Texaco coal gasification process (Economics), 5:23785
Future availability of feedstocks for ammonia production (To 2000), 5:23781
Koppers-Totzek coal gasification process and its role in today's coal-based nitrogenous fertilizer production, 5:23784
Lurgi pressure gasification and its application for ammonia manufacture, 5:23782
Operating experience on a 1,000-ton/day ammonia plant at Modderfontein, 5:23790
Potential importance of coal as a feedstock for the US fertilizer industry in the future, 5:23780
TVA project for production of ammonia from coal, 5:23792
Winkler coal gasification process and its application in ammonia synthesis plants (Economics; Winkler gasification process; pressure dependence; plant size), 5:23783

AMMONIA/REMOVAL
Treatment of waste water effluents from coal gasification units, 5:23434

AMMONIA/SUPPLY AND DEMAND
Impact of ammonia utilization by NOx flue gas treatment processes. Final report August 1977-November 1978, 5:24038 (PB—300596)

AMMONIA/SYNTHESIS
Process for hydrogen recovery from ammonia purge gases (Patent), 5:23777

AMMONIA/TRADE
Changing patterns in world nitrogen fertilizer production and trade, 5:24209 (UCID—18621)

AMMONIUM COMPOUNDS/RADIOLYSIS
Oxidation of Ag^+ and $Ag(NH_3)_2^+$ as studied by pulse radiolysis, 5:24502

AMP
(Adenosine monophosphate.)

AMP/BIOASSAY
Assay of adenosine 3',5' cyclic monophosphate by stimulation of protein kinase: a method not involving radioactivity, 5:24672

AMYLUM
See STARCH

ANEMIAS/BIOLOGICAL EFFECTS
Modulation of erythropoietin concentrations by manipulation of hypercarbia, 5:24690

ANGULAR DISTRIBUTION
Sub-Coulomb transfer reactions on ^{208}Pb with carbon and oxygen projectiles, 5:24933

ANGULAR DISTRIBUTION/ELECTRIC DIPOLES
Manifestation of dynamically unfavored transitions in the angular distribution of photofragments, 5:24831

ANGULAR DISTRIBUTION/ENERGY-LEVEL TRANSITIONS
Manifestation of dynamically unfavored transitions in the angular distribution of photofragments, 5:24831

ANIMAL CELLS
See also STEM CELLS
XP CELLS

ANIMAL CELLS/ELECTROSTATIC SEPARATION
Improved method and apparatus for electrostatically sorting biological cells (DOE patent application), 5:24701

ANIMAL CELLS/MITOTIC DELAY
Reproductive survival and macromolecular synthesis in cultured mammalian cells exposed to single metabolites and mixtures of metabolites of benzo(a)pyrene, 5:24762 (CONF-791059—6)

ANIMAL CELLS/MUTATIONS
Screening for mutagenic response of six coded chemicals in the CHO/HGPRT system, 5:24763 (CONF-7910146—1)

ANIMAL CELLS/TEMPERATURE EFFECTS
Limits to life at low temperatures and at reduced water contents and water activities, 5:24702 (CONF-7810136—2)

ANIMAL CELLS/TOLERANCE
Dependence of mammalian DNA replication on DNA supercoiling. I. Effects of ethidium bromide on DNA synthesis in permeable Chinese hamster ovary cells, 5:24691

ANIMAL FEEDS/HEALTH HAZARDS
Dried, irradiated sewage solids as supplemental feed for cattle, 5:24331 (SAND—80-0989C)

ANNUAL CYCLE ENERGY SYSTEM/ECONOMIC ANALYSIS
Research program on the economic feasibility and commercialization potential of the ACES system. Twenty-fourth periodic progress report, 5:24252 (DOE/CS/02130—T1)

ANNUAL CYCLE ENERGY SYSTEM/ECONOMICS
Economic evaluation of the Annual Cycle Energy System (ACES). Volume II. Detailed results. Final report, 5:24246 (ORNL/Sub—7470/1-V2)

ANNUAL CYCLE ENERGY SYSTEM/OPERATION
Annual Cycle Energy System characteristics and performance, 5:24250 (CONF-800524—2)

ANNUAL CYCLE ENERGY SYSTEM/PERFORMANCE
Annual Cycle Energy System characteristics and performance, 5:24250 (CONF-800524—2)

ANNUAL CYCLE ENERGY SYSTEM/VIABILITY
Economic evaluation of the Annual Cycle Energy System (ACES). Volume II. Detailed results. Final report, 5:24246 (ORNL/Sub—7470/1-V2)

ANODES/ENERGY CONSERVATION
Energy savings by means of fuel cell electrodes in electrochemical industries. Progress report, August 1-October 31, 1978, 5:24498 (COO—4881-3)

ANODES/FABRICATION
Fuel cell anode electrode, method of making the fuel cell anode electrode, and fuel cell containing the fuel cell anode electrode (Patent), 5:24240

ANOXIA/BIOLOGICAL ADAPTATION
Oxygen effect and adaptive reactions of cells. Report 2. Kinetics of respiration of tumor cells differing in initial respiration level (γ rays; Ehrlich ascites tumor cells), 5:24747

ANOXIA/BIOLOGICAL EFFECTS
Modulation of erythropoietin concentrations by manipulation of hypercarbia, 5:24690

ANOXIA/RADIOSENSITIVITY EFFECTS
Oxygen effect and adaptive reactions of cells. Report 2. Kinetics of respiration of tumor cells differing in initial respiration level (γ rays; Ehrlich ascites tumor cells), 5:24747

ANTELOPES/TISSUE DISTRIBUTION
Metals in soft tissues of mule deer and antelope, 5:24775

ANTENNAS
See also RECTENNAS

ANTENNAS/MATHEMATICAL MODELS
Computer modeling of antennas near the ground, 5:24538 (UCID—18626)

ANTENNAS/OPERATION
Computer modeling of antennas near the ground, 5:24538 (UCID—18626)

ANTIBIOTICS
See also ACTINOMYCIN
TETRACYCLINES

ANTIBIOTICS/TOXICITY
Dependence of mammalian DNA replication on DNA supercoiling. II. Effects of novobiocin on DNA synthesis in Chinese Hamster ovary cells, 5:24700

ANTIGENS/AEROSOL MONITORING
Airborne aeroallergen measurements in Houston, Texas. Final report, 5:24602 (PB—299643)

ANTIMONY/ACTIVATION ANALYSIS
Activation analysis, 5:24485

ANTIMONY/BONDING
Bonding of Al and Ga to GaAs(110), 5:24381

ANTIMONY/INTERFACES
Bonding of Al and Ga to GaAs(110), 5:24381

ANTINEOPLASTIC DRUGS/PHARMACOLOGY
Inhibition of DNA excision repair in human cells by Arabinofuranosyl cytosine: effect on normal and xeroderma pigmentosum cells, 5:24688

ANTIPROTONS/PARTICLE PRODUCTION
Search for narrow p-barp states in the reaction $\pi^+ p \rightarrow \Delta/sub\ f/^{++}$ p-barp, 5:24852

ANTIREFLECTION COATINGS/FABRICATION
Preparation of thin films for solar energy utilization, 5:23825

APARTMENT BUILDINGS/SOLAR SPACE HEATING
Feasibility study on a combined summer cooling and winter heating system, based on a combination of solar energy and ground heat pumps, 5:23883 (EUR—6701)

APES/RADIONUCLIDE KINETICS
Cross-placental transfer of ^{243} ^{4}Cm in the baboon, 5:24759 (COO—3382-18)
Curium-243,4 in the tissues of the adult baboon (Time-dependent effects of DTPA administration on excretion), 5:24757 (COO—3382-18)
Improved mathematical model for uranium metabolism, 5:24753 (COO—3382-18)
Microdistribution of ^{243} ^{4}Cm in the ovary of an adult baboon, 5:24758 (COO—3382-18)
Radioactivity studies progress report (Lead abstract), 5:24755 (COO—3382-18)
Short term kinetics of uranium in the adult baboon: preliminary data, 5:24760 (COO—3382-18)

APPARATUS
See EQUIPMENT

APPLIANCES
See also SPACE HEATERS
WATER HEATERS

APPLIANCES/ENERGY CONSUMPTION
Residential energy consumption survey: characteristics of the housing stock and households, 5:24253 (DOE/EIA—0207/2)
AQUACULTURE/FEASIBILITY STUDIES
Getting into hot water: the use of reject heat in aquaculture, 5:24310
AQUACULTURE/WASTE HEAT UTILIZATION
Getting into hot water: the use of reject heat in aquaculture, 5:24310
AQUATIC ECOSYSTEMS/ENVIRONMENTAL IMPACTS
Consequences of natural upwelling in oligotrophic marine ecosystems, 5:23862 (BNL—27710)
AQUATIC ECOSYSTEMS/MEDICAL SURVEILLANCE
Survey of human enterovirus occurrence in fresh and marine surface waters on Long Island, 5:24731
AQUATIC ECOSYSTEMS/PRODUCTIVITY
Shelf-sea ecosystems, 5:24650 (BNL—27406)
AQUATIC ECOSYSTEMS/TOLERANCE
Entrainment, 5:24761
AQUATIC ORGANISMS
(Unspecified biota characteristic of aquatic ecosystems.)
See also CRUSTACEANS
FISHES
MOLLUSCS
AQUATIC ORGANISMS/CHEMICAL ANALYSIS
Strategies for marine pollution monitoring, 5:24653
AQUATIC ORGANISMS/SAMPLING
Strategies for marine pollution monitoring, 5:24653
AQUIFERS/STRUCTURAL MODELS
Preliminary subsurface hydrologic considerations: Columbia River Plateau Physiographic Province. Assessment of effectiveness of geologic isolation systems, 5:23735 (PNL—2859)
ARCHAEOLOGICAL SITES/EXCAVATION
Site 32sn102, Stutsman County, North Dakota: a description and analysis. Final report August-December 1978, 5:24781 (PB—299924)
ARGON 40 REACTIONS/COMPOUND-NUCLEUS REACTIONS
Decay of deformed and superdeformed nuclei formed in heavy ion reactions, 5:24910
ARGON IONS
1979 LEED analysis of Cu(100), 5:24408
ARGON IONS/COLLISIONS
AES and XPS study of plutonium oxidation, 5:24415
Auger spectra induced by 100-keV Ar^+ impact on Be, Al, and Si, 5:24806
Azimuthal anisotropies of dimer ions ejected from ion bombarded Ni(001), 5:24807
ARGON IONS/ION-MOLECULE COLLISIONS
Differential charge transfer to the continuum by ions in atomic hydrogen. Progress report and renewal proposal, 5:24819 (DOE/ER/10512—T1)
ARGON IONS/TRANSMISSION
Experimental limits on deviations from Z^2 dependence of Cerenkov radiation by heavy ions, 5:24950
ARIZONA/BOOM TOWNS
Boomtown impacts of energy development in the Lake Powell Region (Lake Powell Research Project), 5:24665 (PB—301221)
ARIZONA/COAL MINES
Evaluation of the environmental effects of western surface coal mining. Volume II. Mine inventory. Final report, 5:23529 (PB—301249)
ARIZONA/SOLAR PROCESS HEAT
Potential for the use of solar energy in the production of process heat in Arizona, 5:23916 (SERI/TP—333-429)
AROMATICS
See also CONDENSED AROMATICS
DDT
PHENOLS
POLYCYCLIC AROMATIC HYDROCARBONS
AROMATICS/CHEMICAL PREPARATION
High severity process for the production of aromatic hydrocarbons (Patent), 5:23598
AROMATICS/FLUORESCENCE
Photophysics of organic molecules at high pressure, 5:24499 (DOE/ER/01198—1305)
Vibrational relaxation in jet-cooled alkyl benzenes. II. Fluorescence spectra, 5:24812
AROMATICS/POLYMERIZATION
Synthesis of thermosetting polymers from the by-products of coal conversion processes, 5:23450
AROMATICS/WASTE DISPOSAL
Delicate disposal of PCBs, 5:24030
ARSENIC/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
ARSENIC/ACTIVATION ANALYSIS
Activation analysis, 5:24485
ARSENIC/DIFFUSION
Numerical methods for the analysis of laser annealing of doped semiconductor wafers, 5:24368 (K/CSD/INF—79/27)
ASCORBIC ACID/BIOLOGICAL EFFECTS
Primary avian tendon cells in culture: an improved system for understanding malignant transformation, 5:24708
ASHES
See also FLY ASH
ASHES/CHEMICAL COMPOSITION
Characterization of flue gas cleaning (FGC) wastes from coal combustion, 5:23480 (METC/SP—79/10(Pt.1))
Composition and properties of Kentucky power plant ash, 5:24035 (METC/SP—79/10(Pt.1))
Recovery of resource materials from coal ash, 5:23470 (METC/SP—79/10(Pt.1))
ASHES/CHEMICAL PROPERTIES
Composition and properties of Kentucky power plant ash, 5:24035 (METC/SP—79/10(Pt.1))
ASHES/EVAPORATION
Coal combustion studies, 5:24226 (FE—2215-13(Vol.1))
ASHES/LEACHING
Environmentally acceptable disposal of coal conversion solid waste residuals. Progress report, April 21, 1979-July 31, 1979, 5:23458 (DOE/PC/20023—1)
Estimating the leaching potential of coal combustion by-products, 5:23483 (METC/SP—79/10(Pt.2))
ASHES/MARKET
Economic and environmental aspects of a new coal ash recycling/disposal process, 5:23481 (METC/SP—79/10(Pt.1))
ASHES/MATERIALS RECOVERY
Engineering analysis and comparison of new processes for the recovery of resource materials from coal ash (Lime-soda, salt-soda, nitric acid, Calsinter and Bayer processes), 5:23465 (METC/SP—79/10(Pt.1))
Recovery of resource materials from coal ash, 5:23470 (METC/SP—79/10(Pt.1))
ASHES/MEETINGS
Fifth international ash utilization symposium, 5:23460 (METC/SP—79/10(Pt.1))
ASHES/PHYSICAL PROPERTIES
Characterization of flue gas cleaning (FGC) wastes from coal combustion, 5:23480 (METC/SP—79/10(Pt.1))
Composition and properties of Kentucky power plant ash, 5:24035 (METC/SP—79/10(Pt.1))
Material characteristics of power plant bottom ashes and their performance in bituminous mixtures: a laboratory investigation, 5:23502 (METC/SP—79/10(Pt.2))
ASHES/PRODUCTION
Engineering approach for using power plant ash in a structural fill, 5:23497 (METC/SP—79/10(Pt.2))
ASHES/RESEARCH PROGRAMS
Continuing disposal of coal ash, 5:24029
ASHES/REVEGETATION
Revegetation study of eastern and western fly ash, 5:23507 (METC/SP—79/10(Pt.2))
ASHES/REVIEWS
Characterization of flue gas cleaning (FGC) wastes from coal combustion, 5:23480 (METC/SP—79/10(Pt.1))
ASHES/WASTE DISPOSAL
Economic and environmental aspects of a new coal ash recycling/disposal process, 5:23481 (METC/SP—79/10(Pt.1))
Evaluation of ash storage sites: a case history, 5:23479 (METC/SP—79/10(Pt.1))
Revegetation study of eastern and western fly ash, 5:23507 (METC/SP—79/10(Pt.2))
Utilization of ash and scrubber sludge in agriculture: a systems study, 5:23506 (METC/SP—79/10(Pt.2))
ASHES/WASTE PRODUCT UTILIZATION
Ash utilization in bikeway construction, 5:23496 (METC/SP—79/10(Pt.2))
Bottom ash lightweight aggregate, 5:23472 (METC/SP—79/10(Pt.1))
CEGB overview (1966 to 1978), 5:23461 (METC/SP—79/10(Pt.1))
Design and construction of experimental haul road and parking lot facilities utilizing power plant ash, 5:23495 (METC/SP—79/10(Pt.2))
Economic and environmental aspects of a new coal ash recycling/disposal process, 5:23481 (METC/SP—79/10(Pt.1))
Engineering approach for using power plant ash in a structural fill, 5:23497 (METC/SP—79/10(Pt.2))
Fifth international ash utilization symposium, 5:23460 (METC/SP—79/10(Pt.1))
Impact of proposed RCRA regulations on resource recovery and utilization, 5:23463 (METC/SP—79/10(Pt.1))
Material characteristics of power plant bottom ashes and their performance in bituminous mixtures: a laboratory investigation, 5:23502 (METC/SP—79/10(Pt.2))

Performance of waste coal ash as highway subbase course, 5:23500 (METC/SP—79/10(Pt.2))
Utilization of ash and scrubber sludge in agriculture: a systems study, 5:23506 (METC/SP—79/10(Pt.2))
ASTHMA/CORRELATIONS
Asthma and air pollution in the Los Angeles area. Technical report No. 35, 5:24776 (DOE/EV/02874—69)
ASTROCYTOMAS
See NEOPLASMS
ATOM COLLISIONS
See also ION-ATOM COLLISIONS
ATOM COLLISIONS/DISTRIBUTION FUNCTIONS
Time-dependent pair distribution in the mean-field approximation, 5:24825
ATOM COLLISIONS/FORM FACTORS
Integrals of the squared atomic form factor over the momentum transfer, 5:24821
ATOMIC BEAMS/MAGNETIC SHIELDING
Enhanced neutral-beam divergence due to imperfect magnetic shielding, 5:24574
ATOMIC EXPLOSIONS
See NUCLEAR EXPLOSIONS
ATOMIC IONS/IONIZATION
Probability distribution of ionized fragments following inner-shell-vacancy creation, 5:24996
ATOMIC IONS/MULTICHARGED IONS
Probability distribution of ionized fragments following inner-shell-vacancy creation, 5:24996
ATOMS
See also MUONIC ATOMS
ATOMS/DE-EXCITATION
Photon statistics in multiphoton absorption and emission processes, 5:24830
ATOMS/ENERGY-LEVEL TRANSITIONS
What can we learn about nuclear electric dipole moments from parity nonconservation in atomic transitions?, 5:24864
ATOMS/EXCITATION
Photon statistics in multiphoton absorption and emission processes, 5:24830
ATP
(Adenosine triphosphate.)
ATP/BIOASSAY
Rapid ATP assays in perfused mouse liver by ^{31}P NMR, 5:24697
ATP/METABOLISM
Rapid ATP assays in perfused mouse liver by ^{31}P NMR, 5:24697
AUGER ELECTRON SPECTROSCOPY/LINE WIDTHS
Auger lineshape analysis of molecules and solids, 5:24965
AUSTENITIC STEELS/WELDED JOINTS
Delta ferrite-containing austenitic stainless steel resistant to the formation of undesirable phases upon aging (Patent), 5:24360
AUTOMOBILES/EXHAUST GASES
Motor vehicle emissions inspection/maintenance program for South Carolina. Final report, 5:24352 (PB—300304)
AUTOMOBILES/FUEL CONSUMPTION
Modelling the demand for long-distance day trips to the lake district, 5:24289 (PB—300617)
AUTOMOBILES/FUEL ECONOMY
Energy efficiency of various transportation modes, 5:24263 (PB—299994)
AUTOMOBILES/GAS TURBINE ENGINES
Effect of catalyst length and downstream reaction distance on catalytic combustor performance, 5:24337 (DOE/NASA/1040—80/14)
AUTOMOBILES/INSPECTION
Motor vehicle emissions inspection/maintenance program for South Carolina. Final report, 5:24352 (PB—300304)
AUTOMOBILES/MAINTENANCE
Motor vehicle emissions inspection/maintenance program for South Carolina. Final report, 5:24352 (PB—300304)
AUTOMOBILES/OPERATION
Emergency of the auto as the free vote mode, 5:24286
AUTOMOBILES/OWNERSHIP
Automobile mode: present status and future role, 5:24287
Emergency of the auto as the free vote mode, 5:24286
AUTOMOBILES/POLLUTION CONTROL EQUIPMENT
Questions and answers concerning the technical details of inspection and maintenance. Technical report, 5:24354 (PB—301215)
AUTOMOBILES/USES
Automobile mode: present status and future role, 5:24287
AUTOMOTIVE INDUSTRY/ECONOMIC ANALYSIS
Automotive manufacturers' cost/revenue, financial and risk analysis: projected impact of automobile manufacturing on the plastics industry. Final report June 1977-July 1978, 5:24181 (PB—300873)
AUTOMOTIVE INDUSTRY/ENERGY SHORTAGES
Coping with energy limitations in transportation: proposals for Michigan, 5:24179 (PB—299737)
AUTOMOTIVE INDUSTRY/ENERGY SUPPLIES
Coping with energy limitations in transportation: proposals for Michigan, 5:24179 (PB—299737)
AUTOMOTIVE INDUSTRY/RISK ASSESSMENT
Automotive manufacturers' cost/revenue, financial and risk analysis: projected impact of automobile manufacturing on the plastics industry. Final report June 1977-July 1978, 5:24181 (PB—300873)
AUTORADIOGRAPHS
See IMAGES
AVIATION FUELS
See also HYDROGEN FUELS
JET ENGINE FUELS
AVIATION FUELS/HEALTH HAZARDS
Evaluation of comparative toxicity and shipboard hazards of selected petroleum and oil shale-derived fuels, 5:23655
AWAY-FROM-REACTOR STORAGE/STORAGE FACILITIES
AFR/design and licensing information/BNFP as a model. Technical progress report, January-March 1980, 5:23705 (AGNS—47921-TPR-3)
AZULENE/FLUORESCENCE
Photophysics of organic molecules at high pressure, 5:24499 (DOE/ER/01198—1305)

B

BACTERIAL SPORES/BIOLOGICAL RADIATION EFFECTS
Contribution of endogenous and exogenous damage to the total radiation-induced damage in the bacterial spore, 5:24744 (DOE/EV/03221—64)
BAG MODEL/CHIRAL SYMMETRY
Pion and an improved static bag model, 5:24870
BAG MODEL/GROUND STATES
Zero-point energy of confined fermions, 5:24867 (DOE/ER/01545—274)
BALLOONING INSTABILITY/ANALYTICAL SOLUTION
Study of MHD instabilities in elongated tokamaks, 5:25033
BALLOONING INSTABILITY/FINITE ELEMENT METHOD
N-dependence of ballooning instabilities, 5:25026 (PPPL—1663)
BAND THEORY/ENERGY GAP
Stability of the split-band solution and energy gap in the narrow-band region of the Hubbard model, 5:24961
BAND THEORY/FREE ENERGY
Stability of the split-band solution and energy gap in the narrow-band region of the Hubbard model, 5:24961
BAND THEORY/GREEN FUNCTION
Functional-derivative study of the Hubbard model. III. Fully renormalized Green's function, 5:24960
Stability of the split-band solution and energy gap in the narrow-band region of the Hubbard model, 5:24961
BAND THEORY/QUASI PARTICLES
Quasiparticle excitations, the relaxation, and transport properties in the narrow-band regionof the Hubbard model, 5:24962
BAND THEORY/RENORMALIZATION
Functional-derivative study of the Hubbard model. III. Fully renormalized Green's function, 5:24960
BARGES
See also SHIPS
BARGES/ECONOMICS
Comparative costing and capacity measurements: methodological considerations, 5:23551
BARGES/ENERGY EFFICIENCY
Circuity and the energy-intnsiveness of inland waterway and rail freight transport systems: a progress report (Including circuity), 5:23553
BARIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
BARIUM/ENERGY-LEVEL TRANSITIONS
Saturation spectroscopy with laser optical pumping in atomic barium, 5:24813
BARIUM/OPTICAL PUMPING
Saturation spectroscopy with laser optical pumping in atomic barium, 5:24813
BARIUM COMPOUNDS/PRODUCTION
Preparation of hydrosulfides (Patent), 5:24456
BASALT/HYDRAULIC FRACTURING
Effect of principal stress magnitudes on hydrofracturing orientation, 5:24791 (UCRL—15234)
BASALT/MINERALIZATION
Secondary minerals found in the cores DC2 A1 and DC2 A2 taken from the Grande Ronde Basalt Formation, Pasco Basin, Washington, 5:23730 (LBL—10387)
BATTERIES (ELECTRIC)
See ELECTRIC BATTERIES

BATTERY CHARGERS/CONTROL SYSTEMS
System and method for charging electrochemical cells in series (Patent application), 5:24154
BATTERY SEPARATORS/CHEMICAL PREPARATION
Heat and chemically resistant membranes (Polyphenylquinoxaline + polar organic polymer), 5:24166
BATTERY SEPARATORS/PERFORMANCE
Heat and chemically resistant membranes (Polyphenylquinoxaline + polar organic polymer), 5:24166
BAUXITE/SEPARATION PROCESSES
Method of winning aluminum metal from aluminous ore (Patent), 5:24361
BAYARD-ALPERT GAGES/MODULATION
Self-modulating ion gauge, 5:24536
BEAM INJECTION HEATING/TWO-STREAM INSTABILITY
Relativistic electron beam plasma heating experiment, 5:24978 (LA—8226-MS)
BEAM-PLASMA SYSTEMS/ENERGY SPECTRA
Randomness, Maxwellian distributions and resonance absorption, 5:24989
BEAM-PLASMA SYSTEMS/ION BEAMS
Propagation of intense ion beams in straight and tapered z-discharge plasma channels, 5:25081
BEAM-PLASMA SYSTEMS/LASER-RADIATION HEATING
Randomness, Maxwellian distributions and resonance absorption, 5:24989
BEAM-PLASMA SYSTEMS/TWO-STREAM INSTABILITY
Relativistic electron beam plasma heating experiment, 5:24978 (LA—8226-MS)
BENTONITE/STRAIN RATE
A study of the permanent effects of elevated temperature on the hydraulic properties of clay. Master's thesis, 5:24463 (PB—300686)
BENZOPYRENE/BIOASSAY
Aryl hydrocarbon hydroxylase: degradation of product due to contaminant in acetone, 5:24671
BENZOPYRENE/BIOLOGICAL EFFECTS
Reproductive survival and macromolecular synthesis in cultured mammalian cells exposed to single metabolites and mixtures of metabolites of benzo(a)pyrene, 5:24762 (CONF-791059—6)
BERYLLIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
BERYLLIUM/DEPOSITION
Radio frequency magnetron sputtering of thick film amorphous beryllium, 5:24809
BERYLLIUM/ION COLLISIONS
Auger spectra induced by 100-keV Ar^+ impact on Be, Al, and Si, 5:24806
BERYLLIUM/PHOTON TRANSPORT
Z dependence of the laser-intensity threshold for inhibited electron thermal conduction, 5:24951
BERYLLIUM/SPUTTERING
Radio frequency magnetron sputtering of thick film amorphous beryllium, 5:24809
BERYLLIUM 7/REMOVAL
Deposition and control of ^7Be in liquid lithium, 5:25090 (HEDL-SA—1889-FP)
BERYLLIUM 9 REACTIONS/ELASTIC SCATTERING
Dominance of strong absorption in $^9Be + ^{28}Si$ elastic scattering, 5:24903
BERYLLIUM 9 REACTIONS/FUSION REACTIONS
Dominance of strong absorption in $^9Be + ^{28}Si$ elastic scattering, 5:24903
BERYLLIUM MODERATORS
See BERYLLIUM
BESSEL DIFFERENTIAL EQUATION
See FOKKER-PLANCK EQUATION
BETA DECAY/RESEARCH PROGRAMS
Radioactive decay studies at TRISTAN II. Progress report, July 1, 1979-March 31, 1980 (Dept. of Chemistry, Univ. of Maryland, 7/1/79-3/31/80), 5:24887 (DOE/ER/10494—1)
BETA DETECTION/EXOELECTRON DOSEMETERS
Ceramic BeO exoelectron dosimeters for tritium and radon monitoring, 5:24561 (CONF-7910149—1)
BIDS/STATISTICAL MODELS
Modeling the number of bids received on federal offshore hydrocarbon leases by poisson-type models, 5:23601 (LA—8347-MS)
BILE DUCTS
See BILIARY TRACT
BILIARY TRACT/DELAYED RADIATION EFFECTS
Long-term effects of radium exposure in female dial workers: liver function and liver disease, 5:24778
BIOCONVERSION/ECONOMIC IMPACT
Agricultural sector impacts of making ethanol from grain, 5:23776 (SERI/TR—352-554)
BIOLOGICAL INDICATORS/PERFORMANCE TESTING
Screening for mutagenic response of six coded chemicals in the CHO/HGPRT system, 5:24763 (CONF-7910146—1)
BIOLOGICAL REPAIR/BIOLOGICAL PATHWAYS
Deoxyribonucleic acid excision repair in chromatin after ultraviolet irradiation of human fibroblasts in culture, 5:24741
BIOLOGICAL REPAIR/INHIBITION
Inhibition of DNA excision repair in human cells by Arabinofuranosyl cytosine: effect on normal and xeroderma pigmentosum cells, 5:24688
BIOLOGICAL STRESS/RESPONSE MODIFYING FACTORS
Pituitary-adrenal response in neonatal rats, 5:24716
BIOMASS
(All growing organic matter such as plants, trees, grasses, and algae.)
See also AGRICULTURAL WASTES
ALGAE
MAIZE
MANURES
SEAWEEDS
SUGAR BEETS
WOOD
WOOD WASTES
BIOMASS/AVAILABILITY
Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model). Quarterly technical progress report, Februray 1, 1980-April 30, 1980, 5:23835 (DOE/ET/20611—12)
BIOMASS/BIOCONVERSION
Management assessment of energy from biomass and wastes, 5:23839
BIOMASS/ENERGY SOURCE DEVELOPMENT
Energy from biomass and wastes: 1979 update, 5:23841
Management assessment of energy from biomass and wastes, 5:23839
BIOMASS/INFORMATION SYSTEMS
Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model). Quarterly technical progress report, Februray 1, 1980-April 30, 1980, 5:23835 (DOE/ET/20611—12)
BIOMASS/MEETINGS
Management assessment of energy from biomass and wastes, 5:23839
BIOMASS/RESOURCE POTENTIAL
Potentialities of forest biomass as sources of energy, 5:23838 (SRO—1015-T1)
BIOMASS/THERMOCHEMICAL PROCESSES
Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model). Quarterly technical progress report, Februray 1, 1980-April 30, 1980, 5:23835 (DOE/ET/20611—12)
BIOMASS CONVERSION PLANTS/ECONOMIC ANALYSIS
Preliminary energy balance and economic of a farm-scale ethanol plant, 5:23775 (DOE/CS/4042—T36)
BIOMASS CONVERSION PLANTS/ENVIRONMENTAL IMPACTS
Environmental implications of accelerated gasohol production: preliminary assessment, 5:23832 (ANL/ES—91)
BIOMASS CONVERSION PLANTS/FINANCIAL INCENTIVES
National Fuel Alcohol and Farm Commodity Production Act of 1979. Hearings before the Committee on Agriculture, Nutrition, and Forestry, United States Senate, Ninety-Sixth Congress, First Sesson on S. 850, July 17 and 19, 1979, 5:23842
BIOMASS CONVERSION PLANTS/HEARINGS
National Fuel Alcohol and Farm Commodity Production Act of 1979. Hearings before the Committee on Agriculture, Nutrition, and Forestry, United States Senate, Ninety-Sixth Congress, First Sesson on S. 850, July 17 and 19, 1979, 5:23842
BIOMASS CONVERSION PLANTS/NET ENERGY
Preliminary energy balance and economic of a farm-scale ethanol plant, 5:23775 (DOE/CS/4042—T36)
BIOSYNTHESIS/INHIBITION
Reproductive survival and macromolecular synthesis in cultured mammalian cells exposed to single metabolites and mixtures of metabolites of benzo(a)pyrene, 5:24762 (CONF-791059—6)
BISMUTH/MAGNETORESISTANCE
Resistivity anomaly in thin Bi wires: Possibility of a one-dimensional quantum size effect, 5:24405
BISMUTH OXIDES/PRODUCTION
Glass-ceramics for lightning arrestor connector seals, 5:24429 (SAND—80-0215)
BITTER SPAR
See DOLOMITE
BITUMENS
See also COAL TAR

BITUMENS/SOLVENT EXTRACTION
Recovery of bitumen from tar sands (Patent), 5:23640
BITUMINOUS COAL/DILATOMETRY
Effects of preoxidation on the swelling and softening of bituminous coals, 5:23455 (FE—2030-TR20)
BITUMINOUS COAL/SWELLING
Effects of preoxidation on the swelling and softening of bituminous coals, 5:23455 (FE—2030-TR20)
BLACK CHROME/THERMAL DEGRADATION
Survey of selective solar absorbers and their limitations, 5:23954 (SAND—79-2371C)
BLACK SHALES/CHEMICAL COMPOSITION
Characterization, fracturing, and true in situ retorting in the Antrim shale of Michigan, 5:23634
BLACK SHALES/EXPLOSIVE FRACTURING
Characterization, fracturing, and true in situ retorting in the Antrim shale of Michigan, 5:23634
BLACK SHALES/FRACTURING
Fracturing of the Antrim of Michigan, 5:23622
BLACK SHALES/HYDRAULIC FRACTURING
Characterization, fracturing, and true in situ retorting in the Antrim shale of Michigan, 5:23634
BLACK SHALES/IN-SITU COMBUSTION
Energy from in situ processing of antrim oil shale. Quarterly technical progress report, October-December 1979, 5:23627 (FE—2346-58)
Energy from in situ processing of antrim oil shale. Quarterly technical progress report, January-March 1980, 5:23628 (FE—2346-64)
BLACK SHALES/IN-SITU PROCESSING
Extraction of hydrocarbons from Antrim oil shale, 5:23636
BLACK SHALES/IN-SITU RETORTING
Characterization, fracturing, and true in situ retorting in the Antrim shale of Michigan, 5:23634
BLACK SHALES/MAPS
Isopach map of black shale in the Sonyea Group (from well sample studies), 5:23618 (METC/EGSP—108)
BLACK SHALES/PERMEABILITY
Energy from in situ processing of antrim oil shale. Quarterly technical progress report, October-December 1979, 5:23627 (FE—2346-58)
BLANKETS (BREEDING)
See BREEDING BLANKETS
BLAST FURNACES/SLAGS
Slag: a useful form of ash, 5:24312 (METC/SP—79/10(Pt.2))
BLOOD
See also BLOOD CELLS
BLOOD/RADIONUCLIDE KINETICS
Distribution and retention of ^{243} ^{4}Cm in the adult baboon, 5:24756 (COO—3382-18)
BLOOD CELLS
See also ERYTHROCYTES
BLOOD CELLS/CHEMICAL COMPOSITION
Analysis of iron content in individual human red blood cells by electron microprobe and scanning electron microscope, 5:24719
BLOOD DISEASES
See HEMIC DISEASES
BLOOD SERUM/DELAYED RADIATION EFFECTS
Long-term effects of radium exposure in female dial workers: liver function and liver disease, 5:24778
BN-350 REACTOR/ACTIVITY LEVELS
Use of demonstration fast reactor experience in assessing the radiation safety of fast power reactors in the design stage, 5:24061 (PNL-TR—393)
BN-350 REACTOR/PRIMARY COOLANT CIRCUITS
Use of demonstration fast reactor experience in assessing the radiation safety of fast power reactors in the design stage, 5:24061 (PNL-TR—393)
BOILERS/POLLUTION CONTROL EQUIPMENT
Environmental assessment of stationary source NOx control technologies. Annual report no. 2, June 1977-June 1978, 5:24547 (PB—300469)
BOILING WATER REACTORS
See BWR TYPE REACTORS
BONE MARROW CELLS/COLONY FORMATION
Absence of erythroblastic islands in plasma clot culture nd their possible reconstitution after clot lysis, 5:24729
BONE MARROW CELLS/PARATHORMONE
Comparison of the effects of prostaglandin E_2 and parathyroid hormone on plasma calcium concentration and osteoclast function, 5:24698
BONE MARROW CELLS/PROSTAGLANDINS
Comparison of the effects of prostaglandin E_2 and parathyroid hormone on plasma calcium concentration and osteoclast function, 5:24698
BONE TISSUES/MICRODOSIMETRY
Osteosarcomas among beagles exposed to ^{239}Plutonium. Technical report No. 34, 5:24751 (DOE/EV/02874—68)
BONES
See SKELETON
BOOM TOWNS
Boomtown impacts of energy development in the Lake Powell Region (Lake Powell Research Project), 5:24665 (PB—301221)
BOR-60 REACTOR/ENGINEERED SAFETY SYSTEMS
Ensuring safe operation of the BOR-60 experimental fast reactor as an atomic power plant, 5:24079 (PNL-TR—397)
BOR-60 REACTOR/FUEL ELEMENTS
Study of the operational characteristics of the core and irradiated fuel parameters in the BOR-60 reactor, 5:24060 (PNL-TR—398)
BOR-60 REACTOR/REACTOR CONTROL SYSTEMS
Ensuring safe operation of the BOR-60 experimental fast reactor as an atomic power plant, 5:24079 (PNL-TR—397)
BOR-60 REACTOR/REACTOR OPERATION
Ensuring safe operation of the BOR-60 experimental fast reactor as an atomic power plant, 5:24079 (PNL-TR—397)
BOREHOLES/CLOSURES
Bell Canyon Test (BCT) instrumentation development, 5:24571 (SAND—80-0408C)
Role of borehole plugging in the evaluation of the Waste Isolation Pilot Plant, 5:23744 (SAND—80-0502C)
Strategy for evaluating the long-term stability of hole-plugging materials in their geological environments, 5:23743 (SAND—80-0359C)
BOREHOLES/ELECTROMAGNETIC SURVEYS
Cross-borehole electromagnetic probing to locate high-constrast anomalies, 5:24787
BOREHOLES/TABLES
LLL continental drilling for scientific purposes data base: DOE-funded drill holes, 5:24782 (UCRL—52909)
BOREHOLES/WELL LOGGING
Basic data report for Drillhole WIPP 22 (Waste Isolation Pilot Plant, WIPP), 5:23741 (SAND—79-0278)
BORON/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
BORON/DIFFUSION
Infrared reflectiity and transmissivity of boron implanted, laser annealed silicon, 5:24393 (CONF-791112—65)
BORON/EMISSION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
BORON/ENVIRONMENTAL TRANSPORT
Observations on boron release from coal-fired power plants, 5:23532
BORON/HEAT TREATMENTS
Optical band gap of hydrogenated amorphous-boron thin films: The effect of thermal treatment, 5:24454
BORON/OPTICAL PROPERTIES
Infrared reflectiity and transmissivity of boron implanted, laser annealed silicon, 5:24393 (CONF-791112—65)
BORON 10 TARGET/PION REACTIONS
Pion absorption processes (32 to 74 MeV), 5:24896 (COO—3244-72)
BORON CHLORIDES/CHEMICAL PREPARATION
Thionyl chloride electrolytes containing $B_{10}Cl_{10}^{--}$ and $B^{12}Cl_{12}^{--}$, 5:24171
BORON CHLORIDES/ELECTRIC CONDUCTIVITY
Thionyl chloride electrolytes containing $B_{10}Cl_{10}^{--}$ and $B^{12}Cl_{12}^{--}$, 5:24171
BORON IONS/ION-ATOM COLLISIONS
Electron-capture collisions at keV energies of boron and other multiply charged ions with atoms and molecules. II. Atomic hydrogen, 5:24824
BORON OXIDES/PRODUCTION
Glass-ceramics for lightning arrestor connector seals, 5:24429 (SAND—80-0215)
BOTTOMING CYCLES/ECONOMIC ANALYSIS
Design study of a two-phase turbine bottoming cycle. Final report, 5:24309 (DOE/ET/15350—T1)
BOUNDARIES (GRAIN)
See GRAIN BOUNDARIES
BOUNDARY LAYERS/INSTABILITY
Laminar flow cyclone development program. Quarterly technical progress report, July 1, 1979-September 30, 1979, 5:24034 (FE—3242-11)
BOUNDARY LAYERS/NONLINEAR PROBLEMS
Nonlinear analysis of laminar boundary layer flow over a periodic wavy surface: Part II: Long waves, 5:24832
BOUNDARY LAYERS/VISCOSITY
Nonlinear analysis of laminar boundary layer flow over a periodic wavy surface: Part II: Long waves, 5:24832
BOUNDARY LAYERS/WAVELENGTHS
Nonlinear analysis of laminar boundary layer flow over a periodic wavy surface: Part II: Long waves, 5:24832

BREEDING BLANKETS/DESIGN
Production of substitute natural gas by a fusion hybrid reactor coupled to a catalyzed coal gasification plant. Final report, 1 May 1979-1 October 1979, 5:23766 (UWFPP—6)
BREEDING BLANKETS/STRESSES
Stresses in liquid lithium modules in a tokamak blanket due to a changing poloidal magnetic field, 5:25062 (CONF-791102—168)
BREMSSTRAHLUNG (MAGNETIC)
See SYNCHROTRON RADIATION
BRICKS/MANUFACTURING
Role of flyash brick manufacturing in energy conservation, 5:23467 (METC/SP—79/10(Pt.1))
BROMIDES/TOXICITY
Dependence of mammalian DNA replication on DNA supercoiling. I. Effects of ethidium bromide on DNA synthesis in permeable Chinese hamster ovary cells, 5:24691
BROMINE/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
BUILDING MATERIALS
See also BRICKS
CEMENTS
CONCRETE BLOCKS
CONCRETES
BUILDING MATERIALS/DRYING
Demonstration of energy conservation for multi-deck board dryers. Phase I. Final report, 5:24307 (DOE/CS/40167—T1)
BUILDING MATERIALS/FABRICATION
Demonstration of energy conservation for multi-deck board dryers. Phase I. Final report, 5:24307 (DOE/CS/40167—T1)
BUILDING MATERIALS/NATURAL RADIOACTIVITY
Determination of ^{226}Ra, ^{214}Pb, and ^{214}Bi in fly ash samples from eighteen (18) coal fired power plants in the United States, 5:23457 (METC/SP—79/10(Pt.1))
BUILDINGS
See also APARTMENT BUILDINGS
COMMERCIAL BUILDINGS
FEDERAL BUILDINGS
GREENHOUSES
HOSPITALS
HOUSES
OFFICE BUILDINGS
PUBLIC BUILDINGS
RESIDENTIAL BUILDINGS
SCHOOL BUILDINGS
BUILDINGS/ENERGY CONSERVATION
Energy performance standards for new buildings: impact on the use of customer storage, 5:24243 (ANL/EES-TM—81)
BUILDINGS/OFF-PEAK ENERGY STORAGE
Energy performance standards for new buildings: impact on the use of customer storage, 5:24243 (ANL/EES-TM—81)
BUILDINGS/SEISMIC EFFECTS
Microzonation for safer construction-research and application. Proceedings of International Conference (2nd), held at San Francisco, California on November 26-December 1, 1978. Volume I, 5:24783 (PB—301144)
BUILDINGS/SOLAR SPACE HEATING
Development of a site-fabricated, building integrated air collector. Quarterly technical progress report, September 30, 1977-December 31, 1977, 5:23947 (ALO—4123-T2)
Development of a site-fabricated, building integrated air collector. Interim report, September 30, 1077-March 31, 1978, 5:23948 (ALO—4123-T3)
Development of a site-fabricated building integrated air collector. Third quarterly report, March 31-June 30, 1978, 5:23946 (ALO—4123-T1)
BUILDINGS/STANDARDS
Energy performance standards for new buildings: impact on the use of customer storage, 5:24243 (ANL/EES-TM—81)
BUILDINGS/VENTILATION
Impact of reduced infiltration and ventilation on indoor air quality, 5:24624
BURNERS
See also FLUIDIZED-BED COMBUSTORS
GAS BURNERS
OIL BURNERS
BURNERS/FOULING
Burner equipment and operation thereof, 5:24506
BURNERS/OPERATION
Burner equipment and operation thereof, 5:24506
BURST CAN DETECTION
See FAILED ELEMENT DETECTION
BURST SLUG DETECTION
See FAILED ELEMENT DETECTION
BUSES/ENERGY CONSERVATION
Bus maintenance facility environmental analysis. Technical study, 5:24274 (PB—299837)
BUSES/FUEL CONSUMPTION
Characteristics of urban transportation systems: a handbook for transportation planners. Final report, 5:24283 (PB—301319)
BUSES/MAINTENANCE
Bus maintenance facility environmental analysis. Technical study, 5:24274 (PB—299837)
BUSES/MECHANICAL ENERGY STORAGE EQUIPMENT
Hydrobus, gyrobus use brake-generated energy, 5:24350
BUSES/REGENERATIVE BRAKING
Hydrobus, gyrobus use brake-generated energy, 5:24350
BWR TYPE REACTORS/AFTER-HEAT
Fission product decay heat for thermal reactors, 5:24084 (CONF-791058—71)
BWR TYPE REACTORS/DESIGN
Technical report on LWR design decision methodology. Phase I, 5:24044 (SAND—80-0670)
BWR TYPE REACTORS/LOSS OF COOLANT
Best-estimate LOCA radiation signature for equipment qualification, 5:24097 (SAND—80-0888C)
BWR TYPE REACTORS/MELTDOWN
Assessment of molten debris freezing in a severe RIA in-pile test, 5:24088 (CONF-800607—15)
Modeling decay heat-induced melting of a concrete slab by use of the general heat conduction code HEATING 5, 5:24095 (ORNL/TM—7211)
BWR TYPE REACTORS/PRESSURE VESSELS
Determination of K-factors for arbitrarily shaped flaws at pressure vessel nozzle corners, 5:24045 (CONF-791118—11)
BWR TYPE REACTORS/REACTOR INSTRUMENTATION
Acoustic monitoring of relief valve position, 5:24043 (EPRI-NP—1313)
BWR TYPE REACTORS/REACTOR SAFETY
Methology for the selection of LWR safety R & D projects. Phase I, status report, 5:24082 (ALO—66)
BWR TYPE REACTORS/RELIEF VALVES
Acoustic monitoring of relief valve position, 5:24043 (EPRI-NP—1313)
BWR TYPE REACTORS/ROD DROP ACCIDENTS
Assessment of molten debris freezing in a severe RIA in-pile test, 5:24088 (CONF-800607—15)
BWR TYPE REACTORS/VALVES
Pilot program to identify valve failures which impact the safety and operation of light water nuclear power plants, 5:24042 (ALO—75)

C

C INVARIANCE/RADIATIVE DECAY
New upper limit for the C-noninvariant decay $\pi^0 \rightarrow 3\gamma$, 5:24843
CADMIUM/ACTIVATION ANALYSIS
Activation analysis, 5:24485
CADMIUM/METABOLISM
Metals in soft tissues of mule deer and antelope, 5:24775
CADMIUM CHLORIDES/BIOLOGICAL EFFECTS
Effects of divalent metal chlorides on respiration and extractable enzymatic activities of douglas-fir needle litter, 5:24769
CADMIUM SULFIDE SOLAR CELLS/FABRICATION
Commercializatzon of thick film solar cells. Quarterly progress report, September 21, 1979-December 31, 1979, 5:23817 (DSE—4042-T17)
Overview of thick-film technology as applied to solar cells, 5:23821 (SERI/TP—331-541)
CADMIUM SULFIDES/SCREEN PRINTING
Commercializatzon of thick film solar cells. Quarterly progress report, September 21, 1979-December 31, 1979, 5:23817 (DSE—4042-T17)
Overview of thick-film technology as applied to solar cells, 5:23821 (SERI/TP—331-541)
CADMIUM SULFIDES/SPECTRAL RESPONSE
An analysis of the influence of cell parameters and the spectral content of incident light on the performance of Cu2S-CdS solar cells. Technical report, 5:23819 (PB—301050)
CADMIUM TELLURIDE SOLAR CELLS/FABRICATION
Commercializatzon of thick film solar cells. Quarterly progress report, September 21, 1979-December 31, 1979, 5:23817 (DSE—4042-T17)
Sputtered indium-tin oxide/cadmium telluride junctions and cadmium telluride surfaces, 5:23824
CADMIUM TELLURIDE SOLAR CELLS/PERFORMANCE
Sputtered indium-tin oxide/cadmium telluride junctions and cadmium telluride surfaces, 5:23824

CADMIUM TELLURIDES/SCREEN PRINTING
Commercializatzon of thick film solar cells. Quarterly progress report, September 21, 1979-December 31, 1979, 5:23817 (DSE—4042-T17)
CALCIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
CALCIUM/BIOLOGICAL EFFECTS
Comparison of the effects of prostaglandin E_2 and parathyroid hormone on plasma calcium concentration and osteoclast function, 5:24698
CALCIUM/BLOOD PLASMA
Comparison of the effects of prostaglandin E_2 and parathyroid hormone on plasma calcium concentration and osteoclast function, 5:24698
CALCIUM/PROTON REACTIONS
Asymmetry in total scattering of polarized protons by nuclei at 2.1 GeV/s, 5:24839 (LA-tr—80-12)
CALCIUM 40/GIANT RESONANCE
Evidence for an E2 resonance observed by radiative capture of fast neutrons by ^{40}Ca (6 to 13 MeV), 5:24912
CALCIUM 40 TARGET/NEUTRON REACTIONS
Evidence for an E2 resonance observed by radiative capture of fast neutrons by ^{40}Ca (6 to 13 MeV), 5:24912
CALCIUM 40 TARGET/OXYGEN 16 REACTIONS
Decay of deformed and superdeformed nuclei formed in heavy ion reactions, 5:24910
CALCIUM 40 TARGET/PROTON REACTIONS
800-MeV inelastic proton scattering from ^{40}Ca, ^{48}Ca, and ^{54}Fe, 5:24911
CALCIUM 48/ENERGY LEVELS
800-MeV inelastic proton scattering from ^{40}Ca, ^{48}Ca, and ^{54}Fe, 5:24911
CALCIUM 48 TARGET/PROTON REACTIONS
800-MeV inelastic proton scattering from ^{40}Ca, ^{48}Ca, and ^{54}Fe, 5:24911
CALCIUM CHLORIDES/LATENT HEAT STORAGE
Heat transfer and calorimetric studies of a direct contact-latent heat energy storage system, 5:23977
CALCIUM COMPOUNDS/PRODUCTION
Preparation of hydrosulfides (Patent), 5:24456
CALIBRATION/BUILDINGS
LLL calibration and standards facility, 5:24573 (UCRL—84295)
CALIBRATION/LABORATORY EQUIPMENT
LLL calibration and standards facility, 5:24573 (UCRL—84295)
CALIFORNIA
See also COSO HOT SPRINGS
GEYSERS GEOTHERMAL FIELD
IMPERIAL VALLEY
CALIFORNIA/AIR POLLUTION
Detailed characterization of gaseous and size-resolved particulate pollutants at a south coast air basin smog receptor site: levels and modes of formation of sulfate, nitrate and organic particulates and their implications for control strategies. Final report November 1975-June 1978, 5:24620 (PB—301294)
CALIFORNIA/MAGNETOTELLURIC SURVEYS
Magnetotellurics with a remote magnetic reference, 5:24788
CALIFORNIUM 252/SPONTANEOUS FISSION
Fission properties of the heavy actinides, 5:24938
CALORIMETERS/DESIGN
Calorimeter for pulsed energy sources, 5:25086 (CONF-791102—165)
CAMP
See AMP
CANADA/AEROSPACE INDUSTRY
Opportunities in Canadian transportation, 5:24265
CANADA/MEETINGS
Opportunities in Canadian transportation, 5:24265
CANADA/TRAINS
Rail as an industry, 5:24273
CANADA/TRANSPORTATION SYSTEMS
Opportunities in Canadian Transportation, 5:24272
Opportunities in Canadian transportation, 5:24285
Rail as an industry, 5:24273
CANCER
See NEOPLASMS
CANONICAL EQUATIONS
See DIFFERENTIAL EQUATIONS
CAPACITIVE ENERGY STORAGE EQUIPMENT/ELECTRIC FUSES
Preliminary inductive energy transfer experiments, 5:25060
CAPACITY/PLANNING
Literature review on capacity expansion planning under uncertainty. Phase II, 5:24211 (DOE/TIC—11177)
CARBON
See also GRAPHITE
CARBON/ION COLLISIONS
Measurement of the n = 2 density operator for hydrogen atoms produced by passing protons through thin carbon targets, 5:24810
Temperature dependence of the beam-foil interaction, 5:24811
CARBON/PROTON REACTIONS
Asymmetry in total scattering of polarized protons by nuclei at 2.1 GeV/s, 5:24839 (LA-tr—80-12)
CARBON/REMOVAL
Glow discharge conditioning of the PDX vacuum vessel, 5:25097
CARBON 12/ENERGY LEVELS
Photoneutron studies of E1, M1, and E2 excitations in ^{13}C, 5:24897
CARBON 12 REACTIONS/COMPOUND-NUCLEUS REACTIONS
$^{12}C + ^{12}C$ intermediate structures correlated among elastic and reaction channels, 5:24894
CARBON 12 REACTIONS/ELASTIC SCATTERING
$^{12}C + ^{12}C$ intermediate structures correlated among elastic and reaction channels, 5:24894
90° excitation functions for elastic scattering of $^{28}Si + ^{16}O$ and $^{28}Si + ^{12}C$, 5:24908
CARBON 12 REACTIONS/FUSION REACTIONS
Complete fusion of ^{12}C with ^{20}Ne, 5:24907
CARBON 12 REACTIONS/MANY-NUCLEON TRANSFER REACTIONS
Resonances in ^{36}Ar via the $^{24}Mg(^{12}C, \alpha)^{32}S$ reaction (27.5 to 35.5 MeV, excitation functions, angular distributions), 5:24909
CARBON 12 TARGET/CARBON 12 REACTIONS
$^{12}C + ^{12}C$ intermediate structures correlated among elastic and reaction channels, 5:24894
CARBON 12 TARGET/CARBON 13 REACTIONS
$^{12}C(^{13}C, \alpha)^{21}Ne$ reaction. High-spin states, resonances and coherence widths (18 to 32 MeV, excitation functions, angular distributions), 5:24900
CARBON 12 TARGET/MUON REACTIONS
Nuclear disintegration of some complex nuclei by 60-MeV muons, 5:24899
CARBON 12 TARGET/NEUTRON REACTIONS
Photoneutron studies of E1, M1, and E2 excitations in ^{13}C, 5:24897
CARBON 12 TARGET/OXYGEN 16 REACTIONS
Coherence angle in heavy-ion reactions, 5:24895
CARBON 12 TARGET/PION MINUS REACTIONS
Interpretation of quasielastic pion scattering coincidence experiments, 5:24893
CARBON 12 TARGET/PION PLUS REACTIONS
Interpretation of quasielastic pion scattering coincidence experiments, 5:24893
CARBON 12 TARGET/PION REACTIONS
Pion absorption processes (32 to 74 MeV), 5:24896 (COO—3244-72)
CARBON 13/E1-TRANSITIONS
Photoneutron studies of E1, M1, and E2 excitations in ^{13}C, 5:24897
CARBON 13/E2-TRANSITIONS
Photoneutron studies of E1, M1, and E2 excitations in ^{13}C, 5:24897
CARBON 13/M1-TRANSITIONS
Photoneutron studies of E1, M1, and E2 excitations in ^{13}C, 5:24897
CARBON 13 REACTIONS/COMPOUND-NUCLEUS REACTIONS
$^{12}C(^{13}C, \alpha)^{21}Ne$ reaction. High-spin states, resonances and coherence widths (18 to 32 MeV, excitation functions, angular distributions), 5:24900
CARBON 13 TARGET/PHOTONUCLEAR REACTIONS
Photoneutron studies of E1, M1, and E2 excitations in ^{13}C, 5:24897
CARBON 13 TARGET/PION REACTIONS
Pion absorption processes (32 to 74 MeV), 5:24896 (COO—3244-72)
CARBON 14/SCINTILLATION COUNTING
Critical examination of some newly available standards for liquid scintillation counting, 5:24720
CARBON 14/TRACER TECHNIQUES
Compartmentalization of ^{14}C-DDT in an experimental old-field plot, 5:24644
CARBON ADDITIONS/METALLURGICAL EFFECTS
Delta ferrite-containing austenitic stainless steel resistant to the formation of undesirable phases upon aging (Patent), 5:24360
CARBON DIOXIDE/AIR POLLUTION CONTROL
Options for the collection and disposal of carbon dioxide, 5:24036 (ORNL—5657)
CARBON DIOXIDE/CHEMICAL REACTIONS
Gettering of carbon dioxide by erbium thin films, 5:24495 (GEPP-OP—482)

CARBON DIOXIDE/ECONOMIC IMPACT
Consequences of a hypothetical world climate change produced by increased atmospheric carbon dioxide. Progress report, 1 September 1979-31 April 1980, 5:24591 (DOE/EV/10281—1)
CARBON DIOXIDE/ENVIRONMENTAL IMPACTS
Consequences of a hypothetical world climate change produced by increased atmospheric carbon dioxide. Progress report, 1 September 1979-31 April 1980, 5:24591 (DOE/EV/10281—1)
Toward a political analysis of the consequences of a world climate change produced by increasing atmospheric carbon dioxide, 5:24664 (CONF-800475—1)
CARBON DIOXIDE/POLITICAL ASPECTS
Consequences of a hypothetical world climate change produced by increased atmospheric carbon dioxide. Progress report, 1 September 1979-31 April 1980, 5:24591 (DOE/EV/10281—1)
CARBON DIOXIDE/SOCIAL IMPACT
Consequences of a hypothetical world climate change produced by increased atmospheric carbon dioxide. Progress report, 1 September 1979-31 April 1980, 5:24591 (DOE/EV/10281—1)
Toward a political analysis of the consequences of a world climate change produced by increasing atmospheric carbon dioxide, 5:24664 (CONF-800475—1)
CARBON DIOXIDE/WASTE DISPOSAL
Options for the collection and disposal of carbon dioxide, 5:24036 (ORNL—5657)
CARBON DIOXIDE INJECTION/ADDITIVES
Enhanced oil recovery by CO_2 foam flooding. First annual report, 5:23579 (DOE/MC/03259—6)
CARBON DIOXIDE INJECTION/BIBLIOGRAPHIES
Carbon dioxide for the recovery of crude oil: a literature search to June 30, 1979. Final reportp, 5:23577 (DOE/BETC/5785—1)
CARBON DIOXIDE INJECTION/REVIEWS
Carbon dioxide for the recovery of crude oil: a literature search to June 30, 1979. Final reportp, 5:23577 (DOE/BETC/5785—1)
CARBON DIOXIDE LASERS/BIBLIOGRAPHIES
Carbon dioxide lasers. Volume 3. 1976-1977 (a bibliography with abstracts). Report for 1976-77, 5:24523 (NTIS/PS—79/1067)
CARBON DIOXIDE LASERS/POPULATION INVERSION
Conditions for soft x-ray lasing action in a confined plasma column, 5:24528
CARBON FIBERS/SORPTIVE PROPERTIES
Method for making hot-pressed fiber-reinforced carbide-graphite composite (Patent), 5:24455
CARBON IONS/CHEMICAL RADIATION EFFECTS
Production and excision of thymine damage in the DNA of mammalian cells exposed to high-LET radiations, 5:24737
CARBON IONS/ION-ATOM COLLISIONS
Differential charge transfer to the continuum by ions in atomic hydrogen. Progress report and renewal proposal, 5:24819 (DOE/ER/10512—T1)
Electron-capture collisions at keV energies of boron and other multiply charged ions with atoms and molecules. II. Atomic hydrogen, 5:24824
CARBON MONOXIDE/AIR POLLUTION CONTROL
Durability testing at 5 atmospheres of advanced catalysts and catalyst supports for gas turbine engine combustors, 5:24338 (DOE/NASA/9416—80/2)
Evaluation of motor vehicle emissions inspection and maintenance programs in Minnesota. Final report, 5:24353 (PB—301162)
CARBON MONOXIDE/COMBUSTION
Formation and control of fuel-nitrogen pollutants in catalytic combustion of coal-derived gases. Quarterly technical progress report, December 15, 1978-March 15, 1979, 5:23426 (FE—2762-7)
CARBON MONOXIDE/OXIDATION
Formation and control of fuel-nitrogen pollutants in catalytic combustion of coal-derived gases. Quarterly technical progress report, December 15, 1978-March 15, 1979, 5:23426 (FE—2762-7)
CARBON MONOXIDE/SEPARATION PROCESSES
Effect of the degree of hydration of the adsorbent on the chromatographic analysis of common gases, 5:24493 (DP-TR—9)
CARBON OXYSULFIDE/HYDROLYSIS
Carbon monoxide shift catalysts and carbonyl sulfide hydrolysis catalysts, 5:23435
CARBON OXYSULFIDE/REMOVAL
Final sulfur removal in ammonia from coal plants, 5:23416
CARBON STEELS
See also STEEL-ASTM-A533-B
CARBON STEELS/EXPANSION
Hydrogen attack of HSLA steels, 5:24390
CARBONYL RADICALS/FORMATION HEAT
Calculated spectroscopic constants for the X $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$, ^{3}Pi, and ^{1}Pi states of CCO. The heat of formation of CCO, 5:24814
CARBONYL RADICALS/MOLECULAR STRUCTURE
Calculated spectroscopic constants for the X $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$, ^{3}Pi, and ^{1}Pi states of CCO. The heat of formation of CCO, 5:24814
CARBONYL SULFIDE
See CARBON OXYSULFIDE
CARBOXYLIC ACIDS
See also HETEROCYCLIC ACIDS
CARBOXYLIC ACIDS/POLYMERIZATION
Synthesis of thermosetting polymers from the by-products of coal conversion processes, 5:23450
CARCINOGENESIS/DOSE-RESPONSE RELATIONSHIPS
Osteosarcomas among beagles exposed to ^{239}Plutonium. Technical report No. 34, 5:24751 (DOE/EV/02874—68)
CARCINOMAS/CYTOLOGY
In vitro properties of epithelial cell lines established from human carcinomas and nonmalignant tissue, 5:24705
CARCINOMAS/RADIOTHERAPY
Results of a pilot study with extended fractionation in the treatment of lung cancer, 5:24746
CARDIAC PACEMAKERS/PRIMARY BATTERIES
$Li/SOCl_2$ cell as an effective power source (Approx. 1.9 Ah), 5:24149
Use of microcalorimetry in characterization of lithium pacemaker batteries (Lithium/iodine polyvinyl pyridine cells), 5:24148
CARGO/LAND TRANSPORT
Freight transportation energy use, 5:24277 (PB—301152-SET/SL)
Freight transportation energy use. Volume I. Summary and baseline results. Final report August 1976-October 1978, 5:24278 (PB—301153)
Freight transportation energy use. Volume III. Freight network and operations database. Final report August 1976-October 1978, 5:24280 (PB—301155)
Freight transportation energy use. Volume IV. Analysis of selected energy conservation options. Final report August 1976-October 1978, 5:24281 (PB—301156)
CARGO/MARITIME TRANSPORT
Freight transportation energy use. Volume III. Freight network and operations database. Final report August 1976-October 1978, 5:24280 (PB—301155)
CARGO/RAIL TRANSPORT
Freight transportation energy use. Volume I. Summary and baseline results. Final report August 1976-October 1978, 5:24278 (PB—301153)
Freight transportation energy use. Volume III. Freight network and operations database. Final report August 1976-October 1978, 5:24280 (PB—301155)
Freight transportation energy use. Volume IV. Analysis of selected energy conservation options. Final report August 1976-October 1978, 5:24281 (PB—301156)
CARGO/TRANSPORT
Freight transportation energy use. Volume II. Methodology and program documentation. Final report August 1976-October 1978, 5:24279 (PB—301154)
Procedures for multi-state multi-mode analysis: second year's research. Volume II. Final report, 5:24275 (PB—300814)
CARIBOU
See DEER
CARPOOLING/GOVERNMENT POLICIES
Federal energy conservation programs pursuant to section 381 of the Energy Policy and Conservation Act (Public Law 94-163). Annual report to Congress, 5:24190 (DOE/CS—0162)
CASKS/SHOCK ABSORBERS
Cylinder overpack phenolic foam shock testing, 5:24518 (K/P—6567)
CAT SCANNING/IMAGE PROCESSING
Increased tissue differentiation using color display of multiple-energy CT scans, 5:24721
CATALYSTS
See also ELECTROCATALYSTS
CATALYSTS/CHEMICAL PREPARATION
Coal liquefaction catalyst development. Quarterly progress report No. 3, October 1-December 31, 1979, 5:23438 (DOE/ET/14803—T4)
CATALYSTS/PERFORMANCE TESTING
Coal liquefaction catalyst development. Quarterly progress report No. 3, October 1-December 31, 1979, 5:23438 (DOE/ET/14803—T4)
Durability testing at 5 atmospheres of advanced catalysts and catalyst supports for gas turbine engine combustors, 5:24338 (DOE/NASA/9416—80/2)
CATALYSTS/POISONING
Alloy catalysts with monolith supports for methanation of coal-derived gases. Quarterly technical progress report, June 21-September 20, 1979, 5:23425 (FE—2729-8)
CATALYSTS/REGENERATION
Process for regenerating metal-contaminated hydrocarbon conversion catalysts (Patent), 5:23590
CATALYTIC COMBUSTORS/CATALYSTS
Formation and control of fuel-nitrogen pollutants in catalytic combustion of coal-derived gases. Quarterly technical progress report, December 15, 1978-March 15, 1979, 5:23426 (FE—2762-7)

CATALYTIC COMBUSTORS/DESIGN
Effect of catalyst length and downstream reaction distance on catalytic combustor performance, 5:24337 (DOE/NASA/1040—80/14)
CATALYTIC COMBUSTORS/PERFORMANCE
Effect of catalyst length and downstream reaction distance on catalytic combustor performance, 5:24337 (DOE/NASA/1040—80/14)
CATALYTIC CONVERTERS/ENVIRONMENTAL EFFECTS
Investigation of the effects of the installation of an oxidation catalyst on a diesel powered vehicle. Technical report, 5:24351 (PB—299928)
CATAPHORESIS
See ELECTROPHORESIS
CATHODES/ENERGY CONSERVATION
Energy savings by means of fuel cell electrodes in electrochemical industries. Progress report, August 1-October 31, 1978, 5:24498 (COO—4881-3)
CATION EXCHANGE CAPACITY
See CATIONS
CATIONS/BIOCHEMICAL REACTION KINETICS
Ligated chlorophyll cation radicals: their function in photosystem II of plant photosynthesis, 5:24680
CATTLE/ANIMAL FEEDS
Dried, irradiated sewage solids as supplemental feed for cattle, 5:24331 (SAND—80-0989C)
CAVITIES
See also BOREHOLES
CAVITIES/COORDINATES
Cross-borehole electromagnetic probing to locate high-constrast anomalies, 5:24787
CAVITY RECEIVERS/RELIABILITY
Reliability and durability study of a thermal receiver utilizing ASI Type 316 stainless steel in contact with molten aluminum, 5:23860 (SERI/TP—641-653)
CCD
See CHARGE-COUPLED DEVICES
CELL CULTURES/ADENOVIRUS
Primary avian tendon cells in culture: an improved system for understanding malignant transformation, 5:24708
CELL CULTURES/RADIOSENSITIVITY
Mutagenicity and cytotoxicity of 4.4-MeV α particles emitted by plutonium-238, 5:24739
Production and excision of thymine damage in the DNA of mammalian cells exposed to high-LET radiations, 5:24737
Repair of ultraviolet light damage to the DNA of cultured human epidermal keratinocytes and fibroblasts, 5:24742
Xeroderma pigmentosum variants have a slow recovery of DNA synthesis after irradiation with ultraviolet light, 5:24743
CELL CULTURES/TOLERANCE
Modification by cysteamine of ultrasound lethality to Chinese hamster V-79 cells, 5:24779
CELL CYCLE/INHIBITION
Reproductive survival and macromolecular synthesis in cultured mammalian cells exposed to single metabolites and mixtures of metabolites of benzo(a)pyrene, 5:24762 (CONF-791059—6)
CELL FLOW SYSTEMS/DESIGN
Improved method and apparatus for electrostatically sorting biological cells (DOE patent application), 5:24701
CELL KILLING/RADIOINDUCTION
Contribution of endogenous and exogenous damage to the total radiation-induced damage in the bacterial spore, 5:24744 (DOE/EV/03221—64)
CELL MEMBRANES/BIOCHEMICAL REACTION KINETICS
Incorporation of transport molecules into black lipid membranes, 5:24707
CELL MEMBRANES/CPB
Purification of two spectrin-binding proteins: biochemical and electron microscopic evidence for site-specific reassociation between spectrin and bands 2.1 and 4.1, 5:24704
CELL MEMBRANES/RADIOSENSITIVITY EFFECTS
Evidence for a change in the fluidity of erythrocyte membranes following x irradiation by measurement of pyrene excimer fluorescence, 5:24738
CELLS (ANIMAL)
See ANIMAL CELLS
CELLS (PLANT)
See PLANT CELLS
CELLULOSE ESTERS/CHEMICAL PREPARATION
Heat and chemically resistant membranes, 5:24166
CEMENT INDUSTRY/ENERGY CONSERVATION
Research and utilization of Indian fly ashes in cement manufacture: an overview, 5:23492 (METC/SP—79/10(Pt.2))
Use of precalciners to remove alkali from raw material in the cement industry. Quarterly technical progress report, August-October 1979, 5:24291 (COO—4929-5)
CEMENT INDUSTRY/HEAT RECOVERY EQUIPMENT
Potential industrial applications for fluidized-bed waste heat recovery systems, 5:24308 (DOE/CS/40255—1)
CEMENTS
See also GYPSUM CEMENTS
CEMENTS/CHEMICAL COMPOSITION
Cement as admixture to fly ash concrete (Conformite products added to mixture), 5:24311 (METC/SP—79/10(Pt.2))
CEMENTS/CHEMICAL REACTIONS
Mechanical strength development and permeability of fly ash-sludge-lime mixtures, 5:23475 (METC/SP—79/10(Pt.1))
CEMENTS/COMPRESSION STRENGTH
Mechanical strength development and permeability of fly ash-sludge-lime mixtures, 5:23475 (METC/SP—79/10(Pt.1))
CEMENTS/HYDRATION
Hydration development of fly ash cements as measured by the NMR, 5:24462 (METC/SP—79/10(Pt.2))
CEMENTS/NUCLEAR MAGNETIC RESONANCE
Hydration development of fly ash cements as measured by the NMR, 5:24462 (METC/SP—79/10(Pt.2))
CEMENTS/PRODUCTION
New Trief cement process: what has become of Trief cement and portland industry since 1976 (Arguments in favor of new manufacturing process), 5:23493 (METC/SP—79/10(Pt.2))
Use of precalciners to remove alkali from raw material in the cement industry. Quarterly technical progress report, August-October 1979, 5:24291 (COO—4929-5)
CENTRIFUGE ENRICHMENT PLANTS/IAEA SAFEGUARDS
International safeguards at the feed and withdrawal area of a gas centrifuge uranium enrichment plant, 5:23758 (BNL—27663)
CERAMICS/CORROSION
Ceramics Technology Readiness Development Program. Phase I: conceptual designs and material screening. Final report, 5:24019 (FE—2786-38)
CERAMICS/EROSION
Ceramics Technology Readiness Development Program. Phase I: conceptual designs and material screening. Final report, 5:24019 (FE—2786-38)
CERAMICS/MECHANICAL PROPERTIES
Ceramics Technology Readiness Development Program. Phase I: conceptual designs and material screening. Final report, 5:24019 (FE—2786-38)
CERAMICS/NONDESTRUCTIVE TESTING
Development of nondestructive evaluation techniques for high-temperature ceramic heat exchanger components. Tenth quarterly report, January-March 1980, 5:24507 (ANL/MSD/FE—80-2)
CERAMICS/RESEARCH PROGRAMS
Ceramics Technology Readiness Development Program. Phase I: conceptual designs and material screening. Final report, 5:24019 (FE—2786-38)
CERIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
CERIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
CERIUM/EMISSION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
CERIUM/GRUENEISEN CONSTANT
Anomalous behavior of the Grueneisen parameter in cerium near the high-pressure phase transition, 5:24396
CERIUM/PHASE TRANSFORMATIONS
Anomalous behavior of the Grueneisen parameter in cerium near the high-pressure phase transition, 5:24396
CESIUM/ATOM-MOLECULE COLLISIONS
Collisional ionization of Cs and K by O_2, 5:24823
CESIUM 137/RADIOECOLOGICAL CONCENTRATION
Distribution of $^{239,240}Pu$, ^{238}Pu, and ^{137}Cs in various particle size classes of Lake Michigan sediments, 5:24655
CESIUM 137/SORPTION
Sorption studies at Hanford for the control of radioactive wastes, 5:23740 (RHO-SA—155)
CESIUM CHLORIDES/STRESS RELAXATION
Elastic relaxation associated with the formation and motion of Schottky defects in ionic crystals, 5:24459
CFU
(Colony forming units.)
CFU/ULTRASTRUCTURAL CHANGES
Absence of erythroblastic islands in plasma clot culture nd their possible reconstitution after clot lysis, 5:24729
CHALKS
See LIMESTONE
CHARGE CONJUGATION INVARIANCE
See C INVARIANCE
CHARGE-COUPLED DEVICES/NOISE
Noise characterization of the linear CCD, 5:24572 (UCID—18622)

CHARGED PARTICLE DETECTION
See also ALPHA DETECTION
BETA DETECTION
PROTON DETECTION
CHARGED PARTICLE DETECTION/PLASTIC SCINTILLATION DETECTORS
Absolute calibration of a prompt gamma ray detector for intense bursts of protons, 5:24563 (NRL-MR—4171)
CHARGED-PARTICLE TRANSPORT
(For diffusion or transmission of charged particles in material media.)
CHARGED-PARTICLE TRANSPORT/GUIDING-CENTER APPROXIMATION
Guiding center drift equations, 5:25019
CHARGED-PARTICLE TRANSPORT/ORBITS
Guiding center drift equations, 5:25019
CHARGING (REACTOR)
See REACTOR FUELING
CHARM PARTICLES
See also CHARMED BARYON RESONANCES
CHARMED MESON RESONANCES
CHARM PARTICLES/DECAY
Flavor mixing and charm decay, 5:24861 (BNL—27615)
Observation of hadronic charm production in a high resolution streamer chamber experiment, 5:24851
CHARM PARTICLES/PARTICLE PRODUCTION
Observation of hadronic charm production in a high resolution streamer chamber experiment, 5:24851
CHARMED BARYON RESONANCES/PARTICLE PRODUCTION
Recent results from the Mark II detector at SPEAR, 5:24837
CHARMED MESON RESONANCES
See also D RESONANCES
F-2030 RESONANCES
CHARMED MESON RESONANCES/HADRONIC PARTICLE DECAY
Measurement of charmed particle lifetimes, 5:24845
CHARMED MESON RESONANCES/PARTICLE IDENTIFICATION
Recent results from the crystal ball detector at SPEAR, 5:24838
CHARMED MESON RESONANCES/PARTICLE PRODUCTION
Decay $J/\pi \rightarrow 3\gamma$ and a search for the eta/sub c/, 5:24842
CHARMED MESON RESONANCES/PHOTOPRODUCTION
Recent results in photoproduction, 5:24836
CHARS/CATALYTIC EFFECTS
Studies of phenolic compound decomposition under Synthane gasifier conditions. Final report, 5:23420 (FE—0208-T1)
CHARS/GASIFICATION
Experimental program for the development of peat gasification. Task 2. Hydrogasification. Task 3. Fluidized-bed tests. Interim report No. 7, October 1, 1978-July 31, 1979, 5:23424 (FE—2469-48)
CHARS/OXIDATION
Coal combustion studies, 5:24226 (FE—2215-13(Vol.1))
CHEMICAL ANALYSIS
See also MICROANALYSIS
X-RAY FLUORESCENCE ANALYSIS
CHEMICAL ANALYSIS/HOT LABS
Radioactive Materials Analytical Laboratory, 5:24488 (CONF-791103—111)
CHEMICAL EFFLUENTS/POLLUTION REGULATIONS
Treatment of liquid effluents from coal gasification plants, 5:23515
CHEMICAL EXPLOSIVES
See also NITROMETHANE
TNT
CHEMICAL EXPLOSIVES/IGNITION
Power independent ignition energy measurements, 5:24581 (MLM—2709(OP))
CHEMICAL FEEDSTOCKS/AVAILABILITY
Ammonia from coal, 5:23778
Future ammonia business: market and economic considerations (Forecasting), 5:23791
CHEMICAL FEEDSTOCKS/COMPARATIVE EVALUATIONS
Current status of the Texaco coal gasification process, 5:23785
Future availability of feedstocks for ammonia production (To 2000), 5:23781
CHEMICAL FEEDSTOCKS/PRICES
Ammonia from coal, 5:23778
Future ammonia business: market and economic considerations (Forecasting), 5:23791
CHEMICAL HEAT PUMPS/COMMERCIALIZATION
Sulfuric acid and water chemical heat pump/chemical energy storage program. Phase II-A. Final report, 5:23892 (SAND—78-8176)
CHEMICAL HEAT PUMPS/ECONOMIC ANALYSIS
Sulfuric acid and water chemical heat pump/chemical energy storage program. Phase II-A. Final report, 5:23892 (SAND—78-8176)
CHEMICAL HEAT PUMPS/OPTIMIZATION
Sulfuric acid and water chemical heat pump/chemical energy storage program. Phase II-A. Final report, 5:23892 (SAND—78-8176)
CHEMICAL HEAT PUMPS/PERFORMANCE TESTING
Sulfuric acid and water chemical heat pump/chemical energy storage program. Phase II-A. Final report, 5:23892 (SAND—78-8176)
CHEMICAL INDUSTRY/CHEMICAL FEEDSTOCKS
Future ammonia business: market and economic considerations (Forecasting), 5:23791
CHEMICAL INDUSTRY/HEAT RECOVERY EQUIPMENT
Potential industrial applications for fluidized-bed waste heat recovery systems, 5:24308 (DOE/CS/40255—1)
CHEMICAL INDUSTRY/SOLAR PROCESS HEAT
Solar industrial process steam: an economic analysis, 5:23909 (SERI/TP—333-429)
Solar-industrial heat for New York State: a case study in regional impact on economic viability, 5:23911 (SERI/TP—333-429)
Solar production of industrial process steam at Dow Chemical Company's Dalton, Georgia, Latex Manufacturing Plant, 5:23930 (SERI/TP—333-429)
Solar production of industrial process steam for Stauffer Chemical Company, 5:23934 (SERI/TP—333-429)
CHEMICAL LASERS/RESEARCH PROGRAMS
Applied quantum chemistry advanced laser development. Final progress report, 1 October 1978-30 September 1979, 5:24522 (DOE/DP/40100—1)
CHEMISTRY/COMPUTER CALCULATIONS
National resource for computation in chemistry, phase I: evaluation and recommendations, 5:25116 (ORNL/TM—7294)
CHEMISTRY/INFORMATION SYSTEMS
National resource for computation in chemistry, phase I: evaluation and recommendations, 5:25116 (ORNL/TM—7294)
CHERENKOV RADIATION
Experimental limits on deviations from Z^2 dependence of Cerenkov radiation by heavy ions, 5:24950
CHI RESONANCES/PARTICLE DECAY
Measurement of $\gamma\gamma$psi final states in psi' decay, 5:24840
CHI RESONANCES/PARTICLE PRODUCTION
Measurement of $\gamma\gamma$psi final states in psi' decay, 5:24840
CHINA/AGRICULTURE
Handbook on agricultural techniques for state farms, 5:24732 (JPRS—74056)
CHIRAL SYMMETRY/SYMMETRY BREAKING
Exotic new quarks and dynamical symmetry breaking, 5:24874
CHLORATES/CORROSIVE EFFECTS
Nickel-iron alloy corrosion in a sealed pyrotechnic system, 5:24413 (MLM—2707(OP))
CHLORATES/FABRICATION
Shock compaction of a porous pyrotechnic material, 5:24430 (SAND—80-0427C)
CHLORIDES/BIOLOGICAL EFFECTS
Plant developmental system to measure the impact of pollutants in rain water, 5:24768
CHLORINE/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
CHLORINE 35 REACTIONS/FUSION REACTIONS
New isotope ^{199}Rn and evidence for an isomeric state ^{199}Rn/sup m/, 5:24929
CHLOROPHYLL/ELECTRONIC STRUCTURE
Ligated chlorophyll cation radicals: their function in photosystem II of plant photosynthesis, 5:24681
CHLOROPHYLL/MUTATIONS
Genetics of mutagen induced non-lethal chlorophyll mutants in pearl millet, 5:24715
CHLOROPHYLL/OXIDATION
Photooxidation of antenna bacteriochlorophyll in chromatophores from carotenoidless mutant Rhodopseudomonas sphaeroides and the attendant loss of dimeric exciton interaction, 5:24682
CHLOROPHYLL/PHOTOCHEMISTRY
Ligated chlorophyll cation radicals: their function in photosystem II of plant photosynthesis, 5:24680
CHLOROPLASTS/PHOTOCHEMISTRY
Light-dark regulation of starch metabolism in chloroplasts. II. Effect of chloroplastic metabolite levels on the formation of ADP-glucose by chloroplast extracts, 5:24706
Protonmotive cyclic electron flow around photosystem I in intact chloroplasts, 5:24686
Triplet states in photosystem I of spinach chloroplasts and subchloroplast particles, 5:24678
CHROMATES/CORROSION
Refractory materials for coal fueled mhd power generation. Final report, 5:24436 (PB—301095)

CHROMATIN/BIOLOGICAL REPAIR
Deoxyribonucleic acid excision repair in chromatin after ultraviolet irradiation of human fibroblasts in culture, 5:24741
CHROMATIN/FRACTIONATION
Chromatin fractionation procedure that yields nucleosomes containing near-stoichiometric amounts of high mobility group nonhistone chromosomal proteins, 5:24683
CHROMIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
CHROMIUM/ACTIVATION ANALYSIS
Activation analysis, 5:24485
Instrumental analysis of trace elements in thumbnails of human subjects, 5:24484
CHROMIUM ALLOYS
See also CHROMIUM STEELS
NICKEL-CHROMIUM STEELS
CHROMIUM ALLOYS/CORROSION
Nickel-iron alloy corrosion in a sealed pyrotechnic system, 5:24413 (MLM—2707(OP))
CHROMIUM ALLOYS/FABRICATION
Alloys for a liquid metal fast breeder reactor (Patent), 5:24372
CHROMIUM ALLOYS/FRACTURE PROPERTIES
Structure-property relations and the design of Fe-4Cr-C base structural steels for high strength and toughness, 5:24378
CHROMIUM ALLOYS/MAGNETIC PROPERTIES
Microstructure and magnetic properties of Fe-Cr-Co alloys, 5:24373
CHROMIUM ALLOYS/MICROSTRUCTURE
Microstructure and magnetic properties of Fe-Cr-Co alloys, 5:24373
Structure-property relations and the design of Fe-4Cr-C base structural steels for high strength and toughness, 5:24378
CHROMIUM ALLOYS/PHYSICAL RADIATION EFFECTS
Relationship between swelling and the shear modulus of irradiated metal, 5:24421 (HEDL-SA—1774-FP)
Swelling and phase instability in neutron irradiated compositional variants of alloy D9, 5:24420 (DOE/TIC—11202)
CHROMIUM ALLOYS/SWELLING
Relationship between swelling and the shear modulus of irradiated metal, 5:24421 (HEDL-SA—1774-FP)
CHROMIUM ALLOYS/WELDED JOINTS
Delta ferrite-containing austenitic stainless steel resistant to the formation of undesirable phases upon aging (Patent), 5:24360
CHROMIUM OXIDES/CORROSION
Refractory materials for coal fueled mhd power generation. Final report, 5:24436 (PB—301095)
CHROMIUM OXIDES/RAMAN SPECTRA
Raman spectroscopy of surface oxides at elevated temperatures, 5:24464
CHROMIUM STEELS
(Steels containing only chromium as alloying element; see also CHROMIUM-NICKEL STEELS.)
CHROMIUM STEELS/EXPANSION
Hydrogen attack of HSLA steels, 5:24390
CHROMIUM STEELS/FRACTURE PROPERTIES
Structure-property relations and the design of Fe-4Cr-C base structural steels for high strength and toughness, 5:24378
CHROMIUM STEELS/MICROSTRUCTURE
Structure-property relations and the design of Fe-4Cr-C base structural steels for high strength and toughness, 5:24378
CHROMIUM-MOLYBDENUM STEELS/FRACTURE PROPERTIES
Design properties of steels for coal conversion vessels. Interim report, 5:23419 (EPRI-AF—1242)
CHROMODYNAMICS
See QUANTUM CHROMODYNAMICS
CHROMOSOMES/GENETIC MAPPING
Assignment of human β-, γ-, and δ-globin genes to the short arm of chromosome 11 by chromosome sorting and DNA restriction enzyme analysis, 5:24711
Genetic and developmental study of a complex locus in the house mouse. Progress report, August 1, 1978-June 1, 1979, 5:24709 (COO—4159-5)
CIRCULAR POINT COLLECTORS
See PARABOLIC DISH COLLECTORS
CISTRONS
See GENES
CIVIL DEFENSE
Natural Hazards Observer, volume 2, number 4, June 1978, 5:25117 (PB—300976)
CLAMS
See MOLLUSCS
CLAUS PROCESS/CHEMICAL REACTIONS
Claus UCAP (integrated UCAP) sulfur recovery, 5:23436
CLEAN AIR ACT/COMPLIANCE
Impact of air quality control measures, 5:24640 (PB—301234)
CLIMATES/FORECASTING
Modeling the prospects for climatic change: current state-of-the-art and implications, 5:24663 (CONF-800474—1)
CLIMATES/GLOBAL ASPECTS
Aerosols and climate, 5:24589 (CONF-800309—5)
CLIMATES/MATHEMATICAL MODELS
Modeling the prospects for climatic change: current state-of-the-art and implications, 5:24663 (CONF-800474—1)
CLINCH RIVER BREEDER REACTOR/FUEL RODS
Final design analyses of CRBRP fuel rod, 5:24054 (CONF-800607—33)
CLINCH RIVER BREEDER REACTOR/REACTOR FUELING
Self locking drive system for rotating plug of a nuclear reactor (Patent), 5:24065
CLINCH RIVER BREEDER REACTOR/STEAM GENERATORS
Clinch River Breeder Reactor Plant steam generator: FEW tube test model post test examination, 5:24055 (CRBRP-GEFR-SP—176)
CLINTON P ANDERSON MESON PHY. FACILITY
See LAMPF LINAC
CLOSURES/CONTROL SYSTEMS
Self locking drive system for rotating plug of a nuclear reactor (Patent), 5:24065
CO2 FLOODING
See CARBON DIOXIDE INJECTION
COAL
See also BITUMINOUS COAL
LIGNITE
SOLVENT-REFINED COAL
Western coal project (Eastern vs western coal; high sulfur and scrubbers vs low sulfur), 5:23567
COAL/CHEMICAL COMPOSITION
Evaluation of the effects of coal cleaning on fugitive elements. Phase I. Final report, March 1, 1977-January 31, 1978 (Before and after washing), 5:23540 (FE—9145-1)
COAL/COMBUSTION
Theoretical studies on heterogeneous combustion. Progress report, March 1, 1979-February 29, 1980, 5:24022 (COO—4433-3)
COAL/COMPARATIVE EVALUATIONS
Advanced coal gasification system for electric power generation. Quarterly progress report, October 1-December 31, 1978, 5:23421 (FE—1514-97)
Coal technology for ammonia production, 5:23787
COAL/DEVOLATILIZATION
Coal combustion studies, 5:24226 (FE—2215-13(Vol.1))
COAL/DRYING
Kinetic behavior of subbituminous coal drying; effects of confining pressure, 5:23541 (LA-UR—80-551)
COAL/DUSTS
Improved light scattering dust monitor. Open file report (final) 3 August 1977-31 May 1978, 5:24569 (PB—299938)
COAL/EMULSIONS
Evaluation of coal/oil/water slurry (COWS) emulsions produced by an on-line cavitation emulsification process, 5:24023 (FE—3162-T1)
COAL/EXPORTS
Coal and its future (Data for 1978; USA), 5:23565 (METC/SP—79/10(Pt.1))
COAL/FLUIDIZED-BED COMBUSTION
Attrition and elutriation phenomena in industrial atmospheric fluidized bed combustors, 5:23559 (CONF-800545—1)
Utilization of solid material containing combustible matter, 5:23563
COAL/FUEL CONSUMPTION
Coal, 5:23533 (CONF-790949—3)
Coal and its future (Data for 1978; USA), 5:23565 (METC/SP—79/10(Pt.1))
Factors affecting US coal use in the next two decades, 5:23544
Overview of critical issues in coal transportation systems (Forecasting to 1985), 5:23545
COAL/HYDROGENATION
Partial liquefaction of coal by direct hydrogenation. Quarterly progress report, October-December 1979, 5:23445 (FE—2044-51)
COAL/MARKET
Programmer's guide to the Argonne Coal Market Model (USA; mathematical models), 5:23564 (ANL/EES-TM—84)
COAL/MEETINGS
Critical issues in coal transportation systems, 5:23543
COAL/OXIDATION
Study of coal oxidation by charged particle activation analysis, 5:23452 (BNL—27607)
COAL/PETROLOGY
Evaluation of an Automated Reflectance Microscope system for coal characterization. Technical report 18, 5:23454 (FE—2030-TR18)

COAL/PRODUCTION
Coal, 5:23533 (CONF-790949—3)
Coal and its future (Data for 1978; USA), 5:23565 (METC/SP—79/10(Pt.1))
Factors affecting US coal use in the next two decades, 5:23544
Overview of critical issues in coal transportation systems (Forecasting to 1985), 5:23545
COAL/RAIL TRANSPORT
Security problems in the rail transportation of coal, 5:23556
COAL/TRADE
Economics of oceanborne coal transportation, 5:23546
COAL/TRANSPORT
Alternative modes of ocean transportation of coal, 5:23548
Circuity and the energy-intnsiveness of inland waterway and rail freight transport systems: a progress report, 5:23553
Coal transportation systems performance, a current assessment (Ability to respond to strikes, bad weather, small volume shipments, etc.), 5:23555
Communication requisites to socio-institutional adjustments to technological changes in coal transportation, 5:23557
Comparative costing and capacity measurements: methodological considerations, 5:23551
Critical issues in coal transportation systems, 5:23543
Economic considerations of rail and pipeline transportation of coal, 5:23549
Economics of oceanborne coal transportation, 5:23546
Economics of barge transport of coal, 5:23552
Factors affecting US coal use in the next two decades, 5:23544
Great Lakes: a valuable link in the intermodal movement of western coal (Involving transshipment and storage), 5:23554
Overall economics in transportation of coal for export (Optimization of combined transport methods), 5:23547
Overview of critical issues in coal transportation systems (Forecasting to 1985), 5:23545
Selected regulatory issues affecting coal transportation requirements, 5:23550
COAL DEPOSITS/EXPLORATION
Lignite drilling during 1978 in western North Dakota: Adams, Billings, Bowman, Burke, Golden Valley, Hettinger, McKenzie, McLean, and Slope Counties, 5:23535
COAL FINES/COMBUSTION KINETICS
Coal combustion studies, 5:24226 (FE—2215-13(Vol.1))
COAL GAS/CHEMICAL REACTIONS
Method for the direct reduction of iron using gas from coal (Patent), 5:23431
COAL GAS/DESULFURIZATION
Method for the direct reduction of iron using gas from coal (Patent), 5:23431
COAL GASIFICATION
See also IN-SITU GASIFICATION
KOPPERS-TOTZEK PROCESS
LURGI PROCESS
MOLTEN SALT COAL GASIFICATION PROCESS
TEXACO GASIFICATION PROCESS
TRI-GAS PROCESS
WESTINGHOUSE GASIFICATION PROCESS
WINKLER PROCESS
Method for the gasification of carbonaceous matter by plasma arc pyrolysis (Patent), 5:23430
COAL GASIFICATION/CHEMICAL REACTIONS
Coal gasification: the state of the art, 5:23432
COAL GASIFICATION/COMMERCIALIZATION
Coal gasification: the state of the art, 5:23432
COAL GASIFICATION/DEMONSTRATION PLANTS
Pipeline gas demonstration plant. Phase I. Quarterly technical progress report, September-November 1979, 5:23422 (FE—2012-083)
COAL GASIFICATION/DESULFURIZATION
Sulfur fixation during coal gasification. Final report 1 March 1975-28 February 1978, 5:23414 (PB—301104)
COAL GASIFICATION/ECONOMICS
Coal technology for ammonia production, 5:23787
COAL GASIFICATION/HEAT SOURCES
Production of substitute natural gas by a fusion hybrid reactor coupled to a catalyzed coal gasification plant. Final report, 1 May 1979-1 October 1979, 5:23766 (UWFPP—6)
COAL GASIFICATION/MATHEMATICAL MODELS
Coal processing for fuel cell utilization. Task XI. Fluidized bed coal gasification model; data analysis and predictions, 5:23428 (METC—8450-T1)
COAL GASIFICATION/MEETINGS
Ammonia from coal, 5:23778
COAL GASIFICATION/METHANE
Self-disintegrating raney metal alloys (Patent), 5:24370
COAL GASIFICATION/PERFORMANCE TESTING
Advanced development of a short-residencemtime hydrogasifier. Quarterly technical progress report, October 1, 1979-December 31, 1979, 5:23427 (FE—3125-15)
COAL GASIFICATION PLANTS/CHEMICAL EFFLUENTS
Treatment of liquid effluents from coal gasification plants, 5:23515
COAL GASIFICATION PLANTS/CORROSIVE EFFECTS
Materials technology for coal-conversion processes. Nineteenth report, July-December 1979, 5:23417 (ANL—80-12)
COAL GASIFICATION PLANTS/ENVIRONMENTAL EFFECTS
Low/medium Btu gasification: a summary of applicable EPA regulations, 5:23531
COAL GASIFICATION PLANTS/POLLUTION CONTROL
Low/medium Btu gasification: a summary of applicable EPA regulations, 5:23531
COAL GASIFICATION PLANTS/PRESSURE VESSELS
Design properties of steels for coal conversion vessels. Interim report, 5:23419 (EPRI-AF—1242)
COAL GASIFICATION PLANTS/SIMULATION
Development of a modular software system for the dynamic simulation of coal conversion plants. Final report, 5:23423 (FE—2338-14)
COAL GASIFICATION PLANTS/SITE SELECTION
Potential importance of coal as a feedstock for the US fertilizer industry in the future, 5:23780
COAL GASIFICATION PLANTS/SOLID WASTES
Environmentally acceptable disposal of coal conversion solid waste residuals. Progress report, April 21, 1979-July 31, 1979, 5:23458 (DOE/PC/20023—1)
COAL GASIFICATION PLANTS/START-UP
Coal-based ammonia plants: preliminary operating experience of coal gasification at Talcher and Ramagundam fertilizer plants of The Fertilizer Corporation of India, 5:23788
COAL GASIFICATION PLANTS/WASTE WATER
Treatment of waste water effluents from coal gasification units, 5:23434
COAL INDUSTRY/ECONOMIC ANALYSIS
Quadratic programming and spatial equilibrium: the case of coal. Program working papers, 5:23566 (PB—301365)
COAL INDUSTRY/ECONOMIC IMPACT
Boomtown impacts of energy development in the Lake Powell Region (Lake Powell Research Project), 5:24665 (PB—301221)
COAL INDUSTRY/ENVIRONMENTAL IMPACTS
The Yampa River Basin, Colorado and Wyoming--a preview to expanded coal-resource development and its impacts on regional water resources. Water-resources investigations (final), 5:24658 (PB—300815)
COAL INDUSTRY/FINANCIAL INCENTIVES
Analysis of federal incentives used to stimulate energy production: an executive summary, 5:24182 (PNL—2410(Rev.2))
COAL INDUSTRY/LABOR RELATIONS
Communication requisites to socio-institutional adjustments to technological changes in coal transportation, 5:23557
COAL INDUSTRY/MANPOWER
Manpower for the coal mining industry: an assessment of adequacy through the year 2000. Volume II. Technical approach. Final technical report (USA; forecasting), 5:23537 (FE—3134-2)
Manpower for the coal mining industry: an assessment of adequacy through the year 2000. Volume I. Executive summary. Final technical report (USA; forcasting), 5:23536 (FE—3134-1)
COAL LIQUEFACTION/CATALYSTS
Coal liquefaction catalyst development. Quarterly progress report No. 3, October 1-December 31, 1979, 5:23438 (DOE/ET/14803—T4)
COAL LIQUEFACTION/EQUIPMENT
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COAL LIQUEFACTION/PILOT PLANTS
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COAL LIQUEFACTION/TEST FACILITIES
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Coal liquefaction test center. Quarterly report, April 1, 1979-June 30, 1979, 5:23441 (FE—1517-90)
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COAL LIQUEFACTION/YIELDS
Partial liquefaction of coal by direct hydrogenation. Quarterly progress report, October-December 1979, 5:23445 (FE—2044-51)
COAL LIQUEFACTION PLANTS/CAPITAL
Production of synthetic liquids from coal: 1980 to 2000. Preliminary study of potential impediments. Final report (1 to 3 MMBPD by 2000), 5:23449 (FE—3137-T1)

COAL LIQUEFACTION PLANTS/EQUIPMENT
Production of synthetic liquids from coal: 1980 to 2000. Preliminary study of potential impediments. Final report (1 to 3 MMBPD by 2000), 5:23449 (FE—3137-T1)
COAL LIQUEFACTION PLANTS/LABOR
Production of synthetic liquids from coal: 1980 to 2000. Preliminary study of potential impediments. Final report (1 to 3 MMBPD by 2000), 5:23449 (FE—3137-T1)
COAL LIQUEFACTION PLANTS/MATERIALS
Production of synthetic liquids from coal: 1980 to 2000. Preliminary study of potential impediments. Final report (1 to 3 MMBPD by 2000), 5:23449 (FE—3137-T1)
COAL LIQUEFACTION PLANTS/PRESSURE VESSELS
Design properties of steels for coal conversion vessels. Interim report, 5:23419 (EPRI-AF—1242)
COAL LIQUEFACTION PLANTS/RESIDUES
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COAL LIQUEFACTION PLANTS/SIMULATION
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COAL LIQUEFACTION PLANTS/SOLID WASTES
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COAL LIQUIDS/CHEMICAL PROPERTIES
Applied research and evaluation of process concepts for liquefaction and gasification of western coals, 5:23444 (FE—2006-17)
COAL LIQUIDS/CHROMATOGRAPHY
Development and application of analytical techniques to chemistry of donor solvent liquefaction. Quarterly progress report, March-May 1979, 5:23448 (FE—2696-T4)
COAL LIQUIDS/DESULFURIZATION
Applied research and evaluation of process concepts for liquefaction and gasification of western coals, 5:23444 (FE—2006-17)
COAL LIQUIDS/FRACTIONATION
Applied research and evaluation of process concepts for liquefaction and gasification of western coals, 5:23444 (FE—2006-17)
Development and application of analytical techniques to chemistry of donor solvent liquefaction. Quarterly progress report, March-May 1979, 5:23448 (FE—2696-T4)
COAL LIQUIDS/HYDROCRACKING
Upgrading of coal liquids: hydrocracking of EDS process derived gas oils. Interim report, 5:23447 (FE—2566-33)
COAL LIQUIDS/NUCLEAR MAGNETIC RESONANCE
Development and application of analytical techniques to chemistry of donor solvent liquefaction. Quarterly progress report, March-May 1979, 5:23448 (FE—2696-T4)
COAL LIQUIDS/PERFORMANCE TESTING
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COAL LIQUIDS/REFINING
Refining and upgrading of synfuels from coal and oil shales by advanced catalytic processes. Laboratory and Pilot Plant studies of the processing of SRC-I. Second interim report, 5:23446 (FE—2315-45)
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COAL MINERS/PRODUCTIVITY
Manpower for the coal mining industry: an assessment of adequacy through the year 2000. Volume II. Technical approach. Final technical report (USA; forecasting), 5:23537 (FE—3134-2)
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COAL MINES/AEROSOL MONITORING
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COAL MINES/DUSTS
Development of an area sampling methodology. Open file report (final) June 73-October 1975, 5:23523 (PB—299926)
COAL MINES/VENTILATION
Face ventilation system for coal mines (Patent), 5:23570
Sideboard device for improved face ventilation in coal mines. Technical progress report, 5:23568 (PB—300365)
COAL MINES/WASTE PRODUCT UTILIZATION
Utilization of fly ash and coal mine refuse as a road base material. Final report 1973-77, 5:24316 (PB—300761)
COAL MINING
See also ACID MINE DRAINAGE
SURFACE MINING
UNDERGROUND MINING
COAL MINING/BIBLIOGRAPHIES
Annotated bibliography on selected areas of coal mining research and development. Report prepared for the Committee on Science and Technology, US House of Representatives, Ninety-Sixth Congress, First Session by the Congressional Research Service, Library of Congress, 5:23539
COAL MINING/POLLUTION ABATEMENT
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COAL MINING/POLLUTION CONTROL
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COAL MINING/RESEARCH PROGRAMS
Annotated bibliography on selected areas of coal mining research and development. Report prepared for the Committee on Science and Technology, US House of Representatives, Ninety-Sixth Congress, First Session by the Congressional Research Service, Library of Congress, 5:23539
COAL MINING/WATER POLLUTION CONTROL
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COAL PREPARATION/ENVIRONMENTAL EFFECTS
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COAL PREPARATION/ENVIRONMENTAL IMPACTS
Environmental assessment of coal cleaning processes; first annual report. Volume I. Executive summary. Annual report July 1976-September 1977, 5:23526 (PB—300671)
Environmental assessment of coal cleaning processes; first annual report. Volume II. Detailed report. Annual report July 1976-September 1977, 5:23527 (PB—300672)
COAL PREPARATION/HEAVY MEDIA SEPARATION
Use of the magnetic fraction of fly ash as a heavy medium material in coal washing, 5:23542 (METC/SP—79/10(Pt.1))
COAL PREPARATION PLANTS/ENVIRONMENTAL IMPACTS
Environmental assessment of coal cleaning processes; selection of test sites for source test program. Final report December 1977-December 1978, 5:23528 (PB—300673)
COAL PREPARATION PLANTS/POLLUTION CONTROL
Demonstrating the noise control of a coal preparation plant. Volume I. Initial installation and treatment evaluation. Open file report (final), 5:23524 (PB—299963)
COAL RESERVES/GLOBAL ASPECTS
Coal, 5:23533 (CONF-790949—3)
COAL TAR/OXIDATION
Synthesis of thermosetting polymers from the by-products of coal conversion processes, 5:23450
COAL-DERIVED LIQUIDS
See COAL LIQUIDS
COAL-FIRED MHD GENERATORS/COMBUSTORS
Coal combustion studies, 5:24226 (FE—2215-13(Vol.1))
DOE/PETC 5MW two-stage MHD pressurized coal combustor. Quarterly activity report, January 1-March 31, 1980, 5:24217 (COO—4049-16)
COAL-FIRED MHD GENERATORS/ELECTRODES
Electrode module materials evaluation, 5:24223 (FE—2215-13(Vol.1))
Electrode module development, 5:24225 (FE—2215-13(Vol.1))
COAL-FIRED MHD GENERATORS/MATHEMATICAL MODELS
MHD component and system modeling, 5:24219 (FE—2215-13(Vol.2))
COAL-FIRED MHD GENERATORS/PLASMA DIAGNOSTICS
DOE/PETC 5MW two-stage MHD pressurized coal combustor. Quarterly activity report, January 1-March 31, 1980, 5:24217 (COO—4049-16)
COAL-FIRED MHD GENERATORS/RESEARCH PROGRAMS
Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978, 5:24215 (FE—2215-13(Vol.1))
Critical contributions in MHD power generation. Final technical progress report, June 1, 1975-December 30, 1978, 5:24216 (FE—2215-13(Vol.2))

COAL-FIRED MHD GENERATORS/SYSTEMS ANALYSIS
MHD component and system modeling, 5:24219 (FE—2215-13(Vol.2))
COAL-FIRED MHD GENERATORS/TEST FACILITIES
DOE/PETC 5MW two-stage MHD pressurized coal combustor. Quarterly activity report, January 1-March 31, 1980, 5:24217 (COO—4049-16)
COATED FUEL PARTICLES/FABRICATION
Dependence of silicon carbide coating properties on deposition parameters: preliminary report, 5:24050 (ORNL/TM—7209)
COATING (SURFACE)
See SURFACE COATING
COATINGS
See also ANTIREFLECTION COATINGS
VAPOR DEPOSITED COATINGS
COATINGS/PERFORMANCE TESTING
Development and laboratory testing of low Z refractory coatings for fusion reactor limiters, 5:25093 (SAND—79-2409C)
Initial testing of coated limiters in ISX-B, 5:25088 (CONF-800455—8)
Testing of low Z coated limiters in tokamak fusion devices, 5:25092 (SAND—79-2105C)
COBALT/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
COBALT/ACTIVATION ANALYSIS
Instrumental analysis of trace elements in thumbnails of human subjects, 5:24484
COBALT 60/SORPTION
Sorption studies at Hanford for the control of radioactive wastes, 5:23740 (RHO-SA—155)
COBALT ALLOYS/CASTING
Fe-based long range ordered alloys (Patent), 5:24363
COBALT ALLOYS/MAGNETIC PROPERTIES
Microstructure and magnetic properties of Fe-Cr-Co alloys, 5:24373
COBALT ALLOYS/MICROSTRUCTURE
Microstructure and magnetic properties of Fe-Cr-Co alloys, 5:24373
COBALT ALLOYS/ORDER PARAMETERS
Fe-based long range ordered alloys (Patent), 5:24363
COBALT ALLOYS/SORPTIVE PROPERTIES
HVEM in situ hydriding of hydrogen storage materials, 5:24394 (CONF-791132—5)
COBALT SULFIDES/SYNTHESIS
Transition metal sulfide-lithium organic electrolyte rechargeable cells ($CuCo_2S_4$), 5:24165
COGENERATION
See CO-GENERATION
CO-GENERATION/ECONOMICS
District heating and cooling system for communities through power plant retrofit and distribution network. Final report, Phase I, 5:24323 (COO—4980-1)
District heating and cooling through power plant retrofit and distribution network. Final report. Phase 1, executive summary, 5:24324 (COO—4980-1(Exec.Summ.))
CO-GENERATION/FEASIBILITY STUDIES
District heating and cooling through power plant retrofit and distribution network. Final report. Phase 1, executive summary, 5:24324 (COO—4980-1(Exec.Summ.))
Feasibility of a large district heating-cogeneration system for the Minneapolis-St. Paul area, 5:24189 (CONF-7910136—2)
CO-GENERATION/FINANCIAL INCENTIVES
Price incentives of industrial cogeneration, 5:24305 (CONF-800548—1)
CO-GENERATION/REGULATIONS
Analysis of PURPA and solar energy, 5:23799 (SERI/TR—434-484)
CO-GENERATION/STIRLING ENGINES
Design and development of Stirling Engines for stationary power generation applications in the 500 to 3000 hp range. Subtask 1A report: state-of-the-art conceptual design, 5:24010 (DOE/ET/15209—T1)
COKE/PRODUCTION
Method of producing form coke (Patent), 5:23411
COKE/TRANSPORT
Method of transporting liquid pitch containing lumpy cokes and apparatus therefor (Patent), 5:23606
COKE-OVEN GAS
See COAL GAS
COLCHICINE/BIOASSAY
Biochemical studies of mouse brain tubulin: colchicine binding (DEAE-cellulose filter) assay and subunits (α and β) biosynthesis and degradation (in newborn brain), 5:24695 (UR—3490-1559)
COLCHICINE/BIOSYNTHESIS
Biochemical studies of mouse brain tubulin: colchicine binding (DEAE-cellulose filter) assay and subunits (α and β) biosynthesis and degradation (in newborn brain), 5:24695 (UR—3490-1559)
COLCHICINE/CATABOLISM
Biochemical studies of mouse brain tubulin: colchicine binding (DEAE-cellulose filter) assay and subunits (α and β) biosynthesis and degradation (in newborn brain), 5:24695 (UR—3490-1559)
COLIFORMS/ECOLOGICAL CONCENTRATION
Survey of human enterovirus occurrence in fresh and marine surface waters on Long Island, 5:24731
COLLAGEN/BIOSYNTHESIS
Primary avian tendon cells in culture: an improved system for understanding malignant transformation, 5:24708
COLLIERIES
See COAL MINES
COLLISIONLESS PLASMA/ELECTRIC FIELDS
Wave-energy density and wave-momentum density of each speciesof a collisionless plasma, 5:25038
COLLISIONLESS PLASMA/PLASMA WAVES
Method of evaluating the effects of particle scattering by fluctuations, 5:25039
Wave-energy density and wave-momentum density of each speciesof a collisionless plasma, 5:25038
COLONY FORMING UNITS
See CFU
COLORADO/AIR QUALITY
Environmental assessment: DOE/Occidental Oil Shale, Inc. cooperative agreement, Phase II, oil shale retorting, Logan Wash Site, Garfield County, Colorado, 5:23659 (DOE/EA—0095)
COLORADO/COAL MINES
Evaluation of the environmental effects of western surface coal mining. Volume II. Mine inventory. Final report, 5:23529 (PB—301249)
COLORADO/ECOLOGY
Environmental assessment: DOE/Occidental Oil Shale, Inc. cooperative agreement, Phase II, oil shale retorting, Logan Wash Site, Garfield County, Colorado, 5:23659 (DOE/EA—0095)
COLORADO/ENERGY SOURCE DEVELOPMENT
The Yampa River Basin, Colorado and Wyoming--a preview to expanded coal-resource development and its impacts on regional water resources. Water-resources investigations (final), 5:24658 (PB—300815)
COLORADO/GEOCHEMICAL SURVEYS
Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States, 5:23697 (LA-UR—80-1013)
COLORADO/WATER QUALITY
Environmental assessment: DOE/Occidental Oil Shale, Inc. cooperative agreement, Phase II, oil shale retorting, Logan Wash Site, Garfield County, Colorado, 5:23659 (DOE/EA—0095)
COLUMBIA RIVER BASIN/BIBLIOGRAPHIES
Bibliography of the geology of the Columbia Basin and surrounding areas of Washington, 5:23739 (RHO-BWI-C—59)
COLUMBIA RIVER BASIN/GEOLOGY
Bibliography of the geology of the Columbia Basin and surrounding areas of Washington, 5:23739 (RHO-BWI-C—59)
Preliminary subsurface hydrologic considerations: Columbia River Plateau Physiographic Province. Assessment of effectiveness of geologic isolation systems, 5:23735 (PNL—2859)
COLUMBIA RIVER BASIN/HYDROLOGY
Preliminary subsurface hydrologic considerations: Columbia River Plateau Physiographic Province. Assessment of effectiveness of geologic isolation systems, 5:23735 (PNL—2859)
COLUMBIUM
See NIOBIUM
COMBINED COLLECTORS/FEASIBILITY STUDIES
Hybrid photovoltaic/thermal systems with a solar-assisted heat pump, 5:23876 (BNL—27667)
COMBINED-CYCLE POWER PLANTS/ECONOMIC ANALYSIS
Steam injected gas turbine study: an economic and thermodynamic appraisal. Final report, 5:24016 (EPRI-NP—1186)
COMBINED-CYCLE POWER PLANTS/GAS TURBINES
Development of high-temperature turbine subsystem technology to a technology readiness status, Phase II. Quarterly report, January-March 1980, 5:24018 (FE—1806-86)
COMBINED-CYCLE POWER PLANTS/MATERIALS TESTING
Long Term Materials Test Program. Quarterly progress report, January-March 1980, 5:24011 (DOE/ET/15457—10)
COMBINED-CYCLE POWER PLANTS/PERFORMANCE
Steam injected gas turbine study: an economic and thermodynamic appraisal. Final report, 5:24016 (EPRI-NP—1186)

COMBINED-CYCLE POWER PLANTS/RESEARCH PROGRAMS
How much can we rely on a combined-cycle plant, 5:24013
COMBUSTION PRODUCTS/CORROSIVE EFFECTS
High temperature gas turbine engine component materials testing program: Task I. Fireside I. Final report, 5:24017 (FE—1765-44)
COMBUSTORS
See also CATALYTIC COMBUSTORS
COMBUSTORS/CATALYSTS
Durability testing at 5 atmospheres of advanced catalysts and catalyst supports for gas turbine engine combustors, 5:24338 (DOE/NASA/9416—80/2)
COMBUSTORS/DESIGN
Advanced Coal-Fueled Combustor/Heat Exchanger Technology Study. Research and development plan, 5:24012 (FE—2612-16)
COMBUSTORS/PROTECTIVE COATINGS
Advanced electron beam techniques for metallic and ceramic protective coating systems, 5:24293 (LBL—10520)
COMBUSTORS/TESTING
DOE/PETC 5MW two-stage MHD pressurized coal combustor. Quarterly activity report, January 1-March 31, 1980, 5:24217 (COO—4049-16)
COMMERCIAL BUILDINGS
See also RESTAURANTS
COMMERCIAL BUILDINGS/ANNUAL CYCLE ENERGY SYSTEM
Economic evaluation of the Annual Cycle Energy System (ACES). Volume II. Detailed results. Final report, 5:24246 (ORNL/Sub—7470/1-V2)
COMMERCIAL BUILDINGS/ENERGY BUDGETS
Examination of implementation strategies for the Building Energy Performance Standards, 5:24255 (DOE/PE/70106—T1)
COMMERCIAL BUILDINGS/ENERGY CONSUMPTION
Buildings energy use data book. Edition 2, 5:24244 (ORNL—5552)
Examination of implementation strategies for the Building Energy Performance Standards, 5:24255 (DOE/PE/70106—T1)
COMMERCIAL BUILDINGS/HEATING SYSTEMS
R and D activities in pulse combustion at BNL, 5:24248 (BNL—27602)
COMMERCIAL BUILDINGS/SOLAR SPACE HEATING
Solar air systems for space heating, 5:23894
COMMERCIAL SECTOR/ENERGY DEMAND
Energy demand and interfuel substitution in India (Use of translog price possibility frontier), 5:24198
COMMERCIAL SECTOR/FUEL SUBSTITUTION
Energy demand and interfuel substitution in India (Use of translog price possibility frontier), 5:24198
COMMUNITIES/RESIDENTIAL SECTOR
Community planning for home-heating emergencies: a guide for Community-Action Agencies and other community-based organizations (Booklet), 5:24251 (CSA-PAMPHLET—6143-15)
COMMUNITIES (ECOLOGICAL)
See ECOSYSTEMS
COMPETITION/BIOLOGICAL EFFECTS
Size and pattern of simulated forest stands, 5:24669
COMPOSITE MODELS
See also PARTON MODEL
1/N expansion and the theory of composite particles, 5:24882
COMPOUND PARABOLIC CONCENTRATORS
See also PARABOLIC REFLECTORS
COMPOUND PARABOLIC CONCENTRATORS/HEAT LOSSES
Natural convection in inclined two-dimensional compound parabolic concentrators, 5:23972
COMPOUND PARABOLIC CONCENTRATORS/NATURAL CONVECTION
Natural convection in inclined two-dimensional compound parabolic concentrators, 5:23972
COMPOUNDS (ORGANIC)
See ORGANIC COMPOUNDS
COMPUTER AXIAL TOMOGRAPHY SCANNING
See CAT SCANNING
COMPUTER CODES
Analysis of an internally pressurized prismatic cell can (In FORTRAN for IBM 360), 5:24156 (ANL—80-30)
Sealed nickel cadmium cell design by computer modeling (In FORTRAN), 5:24111
COMPUTER CODES/A CODES
ACFAC: a cash flow analysis code for estimating product price from an industrial operation, 5:24069 (ORNL/TM—7150)
ALINET: a model for assessing energy conservation opportunities in the food processing industry. Final technical report, September 1977-December 1979, 5:24298 (DOE/CS/40021—1)
COMPUTER CODES/C CODES
European contribution to heat exchanger design/performance: HTFS research and computer programs. Final report (SCON4 and CEMP1), 5:24510 (DOE/ET/12438—T1)
COMPUTER CODES/COMPUTER-AIDED DESIGN
Concurrent software system design supported by SARA at the age of one, 5:25102
COMPUTER CODES/D CODES
User's manual for DWNWND: an interactive Gaussian plume atmospheric transport model with eight dispersion parameter options, 5:24633 (ORNL/TM—6874)
COMPUTER CODES/H CODES
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)
HLYWD: a program for post-processing data files to generate selected plots or time-lapse graphics, 5:25015 (ORNL/CSD/TM—109)
Modeling decay heat-induced melting of a concrete slab by use of the general heat conduction code HEATING 5 (PWR; BWR), 5:24095 (ORNL/TM—7211)
COMPUTER CODES/P CODES
PABLM: a computer program to calculate accumulated radiation doses from radionuclides in the environment, 5:24754 (PNL—3209)
COMPUTER CODES/PERTURBATION THEORY
1979 LEED analysis of Cu(100), 5:24408
COMPUTER CODES/S CODES
European contribution to heat exchanger design/performance: HTFS research and computer programs. Final report (SCON4 and CEMP1), 5:24510 (DOE/ET/12438—T1)
COMPUTER CODES/T CODES
Single-well chemical tracer test simulator handbook: improved accuracy and interpretation for residual oil saturation measurement (TRACRL), 5:23573 (DOE/BC/20006—14)
TEMP: a computer code to calculate fuel pin temperatures during a transient (LMFBR), 5:24093 (HEDL-TME—75-85)
COMPUTER GRAPHICS/USES
Applications of computer graphics to integrated environmental assessments of energy systems. Milestone report 1976-77, 5:24185 (PB—300358)
COMPUTER NETWORKS/DATA TRANSMISSION
Packet switching (Contains glossary), 5:25109 (EGG—2015)
COMPUTER PROGRAMMING
See PROGRAMMING
COMPUTERS/MANUALS
Radian DART microcomputer system hardware documentation operation system description. DART II documentation, 5:25107 (COO—4596-1(Vol.3))
COMPUTERS/MEETINGS
AESOP XX: summary of proceedings (Gatlinburg, Tennessee, April 24 to 26, 1979), 5:25106 (CONF-790431—(Summ.))
CONCENTRATING COLLECTORS
See also SLAT TYPE COLLECTORS
CONCENTRATING COLLECTORS/SOLAR TRACKING
Solar tracking system for line focusing collectors, 5:23955 (SERI/TP—333-429)
CONCENTRATING COLLECTORS/TECHNOLOGY ASSESSMENT
Technology assessment: line-focus concentrators, 5:23958 (SERI/TP—333-429)
CONCENTRATOR SOLAR CELLS/DESIGN
Luminescent solar collector (Patent), 5:23826
CONCENTRATOR SOLAR CELLS/EFFICIENCY
Luminescent solar collector (Patent), 5:23826
CONCENTRATOR SOLAR CELLS/FABRICATION
Advanced photovoltaic concentrator cells. Quarterly technical progress report No. 1, August 28, 1979-November 30, 1979, 5:23818 (DSE—4042-T30)
CONCENTRATOR SOLAR CELLS/GRADED BAND GAPS
Advanced photovoltaic concentrator cells. Quarterly technical progress report No. 1, August 28, 1979-November 30, 1979, 5:23818 (DSE—4042-T30)
CONCRETE BLOCKS/SOLAR DRYING
Solar industrial process hot water for cement block manufacture, 5:23919 (SERI/TP—333-429)
CONCRETES/COMPRESSION STRENGTH
Cement as admixture to fly ash concrete (Conformite products added to mixture), 5:24311 (METC/SP—79/10(Pt.2))
Characteristics of Australian flyash concrete, 5:23486 (METC/SP—79/10(Pt.2))
Laboratory study of the effects of SO_3 and autoclave expansion of fly ash on concrete expansion and compressive strength, 5:23485 (METC/SP—79/10(Pt.2))
CONCRETES/FABRICATION
Polymer concrete composites for the production of high strength pipe and linings in high temperature corrosive environments (Patent), 5:24444
CONCRETES/FLEXURAL STRENGTH
Cement as admixture to fly ash concrete (Conformite products added to mixture), 5:24311 (METC/SP—79/10(Pt.2))
Characteristics of Australian flyash concrete, 5:23486 (METC/SP—79/10(Pt.2))

CONCRETES/MECHANICAL PROPERTIES
Experimental cements with fly ashes, 5:23494 (METC/SP—79/10(Pt.2))
Structural properties of concrete with fly ash, 5:24461 (METC/SP—79/10(Pt.2))
CONCRETES/PERFORMANCE
Water loss in fast project interim fuel storage rack, 5:24092 (EGG-FM—5078)
CONCRETES/POLYMERIZATION
High temperature chemically resistant polymer concrete (Patent), 5:24443
CONCRETES/PRODUCTION
High temperature chemically resistant polymer concrete (Patent), 5:24443
High temperature concrete composites containing organosiloxane crosslinked copolymers (Patent), 5:24439
CONCRETES/QUALITY CONTROL
Laboratory study of the effects of SO_3 and autoclave expansion of fly ash on concrete expansion and compressive strength, 5:23485 (METC/SP—79/10(Pt.2))
CONCRETES/SPECIFICATIONS
Fly ash in paving and structural concrete, 5:23489 (METC/SP—79/10(Pt.2))
CONCRETES/TENSILE PROPERTIES
Characteristics of Australian flyash concrete, 5:23486 (METC/SP—79/10(Pt.2))
CONDENSED AROMATICS
See also BENZOPYRENE
PYRENE
CONDENSED AROMATICS/FLUORESCENCE
Photophysics of organic molecules at high pressure, 5:24499 (DOE/ER/01198—1305)
CONFIGURATION INTERACTION/BIOCHEMICAL REACTION KINETICS
Quaternay structure and spin state of human fetal methemoglobin. Progress report, September 1, 1979-July 1, 1980, 5:24670 (DOE/EV/03221—65)
CONFORMATIONAL CHANGES/RADIOINDUCTION
Chain inequivalence in bovine methemoglobin. Progress report, December 1, 1979-November 30, 1980, 5:24733 (DOE/EV/03221—61)
CONNECTICUT/ENERGY CONSERVATION
Three point program to reduce fuel consumption, traffic congestion, and air pollution - status report (connecticut), 5:24355 (PB—301224)
CONNECTORS/SEALS
Glass-ceramics for lightning arrestor connector seals, 5:24429 (SAND—80-0215)
CONSERVATION (ENERGY)
See ENERGY CONSERVATION
CONSTRUCTION/SAFETY
Microzonation for safer construction-research and application. Proceedings of International Conference (2nd), held at San Francisco, California on November 26-December 1, 1978. Volume I, 5:24783 (PB—301144)
CONTACTORS
See SWITCHES
CONTAINERS
See also CASKS
PRESSURE VESSELS
TANKS
CONTAINERS/SURFACE TREATMENTS
Effect of container preparation on the growth of protium and methane impurities into tritium gas, 5:25095
CONTAINERS/TESTING
Cable tray fire tests, 5:24446 (EPRI-EL—1263)
CONTAMINATION (INTERNAL)
See RADIONUCLIDE KINETICS
CONTAMINATION (SURFACE)
See SURFACE CONTAMINATION
CONTINENTAL SHELF/FOOD CHAINS
Shelf-sea ecosystems, 5:24650 (BNL—27406)
CONTINENTAL SHELF/PETROLEUM DEPOSITS
Alaska OCS Socioeconomic Studies Program. Technical rept. No. 38. Western Gulf of Alaska petroleum development scenarios: economic and demographic impacts, 5:23602 (PB—300697)
CONTINENTAL SHELF/WATER POLLUTION
Outer continental shelf environmental monitoring concerns. Final report, 5:23607 (PB—299861)
CONTROL SYSTEMS
(For automated processes including feedback.)
CONTROL SYSTEMS/DESIGN
Self locking drive system for rotating plug of a nuclear reactor (Patent), 5:24065
CONTROL SYSTEMS/RELIABILITY
Microprocessor-controlled scanning densitometer system, 5:24565 (DOE/ID/01570—T4)
CONTROL THEORY (REACTOR)
See REACTOR KINETICS
CONVECTIVE INSTABILITIES
Characteristics and lifetime of convective plasma motions in tokamaks, 5:25034
CONVEYORS/COATINGS
Process of treating bituminous sands conveyor belt with release agent (Patent), 5:23641
COOK INLET
See GULF OF ALASKA
COOLERS
See HEAT EXCHANGERS
COOLING PONDS/AERATION
Investigations of sparging as a method for promoting cooling pond heat transfer, 5:24530
COOLING PONDS/HEAT TRANSFER
Investigations of sparging as a method for promoting cooling pond heat transfer, 5:24530
COOLING SYSTEMS/COST
Optimization technique for minimizing the cost of self-powering industrial HVAC systems, 5:24304
COOLING SYSTEMS/WATER TREATMENT
Summary of equilibrium and process model data acquisition: treatment of recirculated cooling water, Resource Document 1. Interim report, 5:24007 (EPRI-FP—1251)
COOLING TOWERS/DYNAMIC LOADS
Analytical method for determining seismic response of cooling towers on footing foundations. Interim report no. 1, 5:24009 (PB—301308)
COOLING TOWERS/SEISMIC EFFECTS
Analytical method for determining seismic response of cooling towers on footing foundations. Interim report no. 1, 5:24009 (PB—301308)
COOLING TOWERS/WATER TREATMENT
Summary of equilibrium and process model data acquisition: treatment of recirculated cooling water, Resource Document 1. Interim report, 5:24007 (EPRI-FP—1251)
COOLING WATER CHEMICAL TREATMENT
See WATER CHEMISTRY
COPPER/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
COPPER/ACTIVATION ANALYSIS
Activation analysis, 5:24485
COPPER/BIOLOGICAL ACCUMULATION
Examination of the effects of 50 ppB copper on the black abalone, Haliotis cracherodii, 5:24770 (UCRL—52932)
COPPER/BIOLOGICAL EFFECTS
Effects of divalent metal chlorides on respiration and extractable enzymatic activities of douglas-fir needle litter, 5:24769
COPPER/BIOLOGICAL LOCALIZATION
Examination of the effects of 50 ppB copper on the black abalone, Haliotis cracherodii, 5:24770 (UCRL—52932)
COPPER/CATALYTIC EFFECTS
Catalyst for synthesis of methanol (Patent), 5:23774
COPPER/CRYSTAL STRUCTURE
1979 LEED analysis of Cu(100), 5:24408
COPPER/ELECTRON DIFFRACTION
1979 LEED analysis of Cu(100), 5:24408
COPPER/EXPLOSION WELDING
Viscosity of metals in explosive welding, 5:24371 (UCRL-Trans—11542)
COPPER/MATERIALS RECOVERY
A pollution-free system for the economic utilization of municipal solid waste, task 10, electrochemical recovery of non ferrous metals derived from municipal refuse, 5:24326 (PB—299753)
COPPER/METABOLISM
Metals in soft tissues of mule deer and antelope, 5:24775
COPPER/PHYSICAL RADIATION EFFECTS
Experimental observations of effects of inert gas on cavity formation during irradiation, 5:24423 (ORNL/TM—7193)
COPPER/PION MINUS REACTIONS
Products of stopped-pion interactions with Cu and Ta, 5:24914
COPPER/PION PLUS REACTIONS
Products of stopped-pion interactions with Cu and Ta, 5:24914
COPPER/SURFACE COATING
Method of manufacturing a niobium-aluminum-germanium superconductive material (Patent), 5:24362
COPPER/TOXICITY
Examination of the effects of 50 ppB copper on the black abalone, Haliotis cracherodii, 5:24770 (UCRL—52932)
COPPER 63 TARGET/MUON REACTIONS
Nuclear disintegration of some complex nuclei by 60-MeV muons, 5:24899
COPPER OXIDES/ANNEALING
Cuprous oxide photovoltaic cells. Third quarterly technical progress report, October 9, 1979-January 8, 1980, 5:23806 (DOE/ET/23010—12)

COPPER OXIDES/CRYSTAL DOPING
Cuprous oxide photovoltaic cells. Third quarterly technical progress report, October 9, 1979-January 8, 1980, 5:23806 (DOE/ET/23010—12)
COPPER OXIDES/DIFFUSION LENGTH
Cuprous oxide photovoltaic cells. Third quarterly technical progress report, October 9, 1979-January 8, 1980, 5:23806 (DOE/ET/23010—12)
COPPER SULFIDES/SPECTRAL RESPONSE
An analysis of the influence of cell parameters and the spectral content of incident light on the performance of Cu2S-CdS solar cells. Technical report, 5:23819 (PB—301050)
COPPER SULFIDES/SYNTHESIS
Transition metal sulfide-lithium organic electrolyte rechargeable cells ($CuCo_2S_4$), 5:24165
CORIUM/SOLIDIFICATION
Assessment of molten debris freezing in a severe RIA in-pile test (PWR; BWR), 5:24088 (CONF-800607—15)
CORN (MAIZE)
See MAIZE
CORN STOVER
See AGRICULTURAL WASTES
CORRELATED-PARTICLE MODELS/SURFACE ENERGY
Wave-vector decomposition of the exchange and correlation contributions to a metallic surface energy, 5:24967
CORTEX (ADRENAL)
See ADRENAL GLANDS
COSMOLOGICAL MODELS
Horizon problem and the broken-symmetric theory of gravity, 5:24799
COSMOS
See UNIVERSE
COSO HOT SPRINGS/HYDROTHERMAL SYSTEMS
Impacts of deep geothermal fluid production on shallow groundwater systems, 5:23983 (CONF-7910155—1)
COUNTING RATES/TEMPERATURE DEPENDENCE
Studies of long-term ecological effects of exposure to uranium V, 5:24647 (LA—8221)
COUPLED CHANNEL THEORY/COULOMB FIELD
Techniques for heavy-ion coupled-channels calculations. I. Long-range Coulomb coupling, 5:24943
COUPLED CHANNEL THEORY/HEAVY ION REACTIONS
Techniques for heavy-ion coupled-channels calculations. II. Iterative solution of the coupled radial equations, 5:24944
CRABS
See CRUSTACEANS
CRACKS/COMPUTERIZED SIMULATION
Computer simulation of crack propagation, 5:24964
CRANKING MODEL/ANGULAR MOMENTUM
Angular momentum fluctuation energy in the cranking model, 5:24949
CRBR REACTOR
See CLINCH RIVER BREEDER REACTOR
CRESOLS/DECOMPOSITION
Studies of phenolic compound decomposition under Synthane gasifier conditions. Final report, 5:23420 (FE—0208-T1)
CRESYLIC ACID
See CRESOLS
CROPS/SACCHARIFICATION
Carbohydrate crops as a renewable resource for fuels production. Volume III. Juice preservation, 5:23833 (BMI—2031(Vol.3))
CROSS SECTIONS/ACCURACY
Covariances of fission-integral measurements at the NBS ^{252}Cf and ISNF facilities and at the ORNL-PCA facility, 5:24070 (CONF-791051—23)
CROSS SECTIONS/NUCLEAR DATA COLLECTIONS
Covariances of fission-integral measurements at the NBS ^{252}Cf and ISNF facilities and at the ORNL-PCA facility, 5:24070 (CONF-791051—23)
CRUDE OIL
See PETROLEUM
CRUSTACEANS
See also DAPHNIA
CRUSTACEANS/ONTOGENESIS
Changes in ecdysteroids during embryogenesis of the blue crab, callinectes sapidus rathbun, 5:24687
CRYOPUMPS/PERFORMANCE TESTING
Direct cryosorption pumping of an energetic hydrogen ion beam, 5:25087 (CONF-791102—171)
CRYSTAL LATTICES/GROUND STATES
Model valence-fluctuation systems: variational ground states and magnetic responses, 5:24955 (LA-UR—80-1005)
CRYSTAL LATTICES/MAGNETIC SUSCEPTIBILITY
Model valence-fluctuation systems: variational ground states and magnetic responses, 5:24955 (LA-UR—80-1005)
CRYSTAL MODELS
(For theories only.)
CRYSTAL MODELS/ELECTRONIC STRUCTURE
Calculating properties with the coherent-potential approximation, 5:24958
CRYSTALS
See also IONIC CRYSTALS
LIQUID CRYSTALS
CRYSTALS/COULOMB ENERGY
Comment on "Correction to Fuchs' calculation of the electrostatic energy of a Wigner solid", 5:24963
CRYSTALS/DISLOCATIONS
Point-obstacle representation of the dislocation-obstacle interaction, 5:24383
CRYSTALS/STABILITY
Comment on "Correction to Fuchs' calculation of the electrostatic energy of a Wigner solid", 5:24963
CT SCANNING
See CAT SCANNING
CULM/CALORIFIC VALUE
Design, construction, operation and evaluation of a prototype culm combustion boiler/heater unit: site evaluation and socio-economic impact, 5:23459 (FE—3269-11A)
CULM/CHEMICAL COMPOSITION
Design, construction, operation and evaluation of a prototype culm combustion boiler/heater unit: site evaluation and socio-economic impact, 5:23459 (FE—3269-11A)
CULM/FLUIDIZED-BED COMBUSTION
Design, construction, operation and evaluation of a prototype culm combustion boiler/heater unit: site evaluation and socio-economic impact, 5:23459 (FE—3269-11A)
CULTURES (CELLS)
See CELL CULTURES
CURIUM/ION EXCHANGE
Kilogram-scale purification of americium by ion exchange, 5:23703 (PNL-SA—7844)
CURIUM/MAGNETIC SUSCEPTIBILITY
Micromagnetic susceptometer, 5:24578
CURIUM 243/MEMBRANE TRANSPORT
Cross-placental transfer of ^{243} ^{4}Cm in the baboon, 5:24759 (COO—3382-18)
CURIUM 243/METABOLISM
Distribution and retention of ^{243} ^{4}Cm in the adult baboon, 5:24756 (COO—3382-18)
Radioactivity studies progress report (Lead abstract), 5:24755 (COO—3382-18)
CURIUM 243/TISSUE DISTRIBUTION
Curium-243,4 in the tissues of the adult baboon (Time-dependent effects of DTPA administration on excretion), 5:24757 (COO—3382-18)
Distribution and retention of ^{243} ^{4}Cm in the adult baboon, 5:24756 (COO—3382-18)
Microdistribution of ^{243} ^{4}Cm in the ovary of an adult baboon, 5:24758 (COO—3382-18)
Radioactivity studies progress report (Lead abstract), 5:24755 (COO—3382-18)
CURIUM 243/UPTAKE
Microdistribution of ^{243} ^{4}Cm in the ovary of an adult baboon, 5:24758 (COO—3382-18)
CURIUM 244/MEMBRANE TRANSPORT
Cross-placental transfer of ^{243} ^{4}Cm in the baboon, 5:24759 (COO—3382-18)
CURIUM 244/METABOLISM
Distribution and retention of ^{243} ^{4}Cm in the adult baboon, 5:24756 (COO—3382-18)
Radioactivity studies progress report (Lead abstract), 5:24755 (COO—3382-18)
CURIUM 244/PURIFICATION
Kilogram-scale purification of americium by ion exchange, 5:23703 (PNL-SA—7844)
CURIUM 244/TISSUE DISTRIBUTION
Curium-243,4 in the tissues of the adult baboon (Time-dependent effects of DTPA administration on excretion), 5:24757 (COO—3382-18)
Distribution and retention of ^{243} ^{4}Cm in the adult baboon, 5:24756 (COO—3382-18)
Microdistribution of ^{243} ^{4}Cm in the ovary of an adult baboon, 5:24758 (COO—3382-18)
Radioactivity studies progress report (Lead abstract), 5:24755 (COO—3382-18)
CURIUM 244/UPTAKE
Microdistribution of ^{243} ^{4}Cm in the ovary of an adult baboon, 5:24758 (COO—3382-18)
CYCLIC ADENOSINE MONOPHOSPHATE
See AMP
CYCLONE SEPARATORS/BOUNDARY LAYERS
Laminar flow cyclone development program. Quarterly technical progress report, July 1, 1979-September 30, 1979, 5:24034 (FE—3242-11)

CYCLOTRON RADIATION/ANALYTICAL SOLUTION
Cyclotron radiation by a multi-group method, 5:25011 (COO—2218-160)
CYLINDRICAL PARABOLIC COLLECTORS
See PARABOLIC TROUGH COLLECTORS
CYTOCHROMES/RADIOLYSIS
Iron hexacyanide/cytochrome-C - intramolecular electron transfer and binding constants - (pulse radiolytic study). Progress report, 5:24504 (DOE/EV/03221—66)
CYTOLOGICAL TECHNIQUES/SORTING
Improved method and apparatus for electrostatically sorting biological cells (DOE patent application), 5:24701

D

D PLUS RESONANCES
See D-1865 RESONANCES
D RESONANCES
See also D-1865 RESONANCES
D RESONANCES/DECAY
Recent results from the Mark II detector at SPEAR, 5:24837
D ZERO RESONANCES
See D-1865 RESONANCES
D-1865 RESONANCES/DECAY
Flavor mixing and charm decay, 5:24861 (BNL—27615)
D-1865 RESONANCES/WEAK HADRONIC DECAY
Troubles with nonleptonic charm decays, 5:24866
DAPHNIA/TOXICITY
Potential toxic effects on aquatic biota from oil shale development, 5:23666
DATA BASE MANAGEMENT/MEETINGS
AESOP XX: summary of proceedings (Gatlinburg, Tennessee, April 24 to 26, 1979), 5:25106 (CONF-790431—(Summ.))
DATA PROCESSING/MEETINGS
AESOP XX: summary of proceedings (Gatlinburg, Tennessee, April 24 to 26, 1979), 5:25106 (CONF-790431—(Summ.))
DATA PROCESSING/RECORDING SYSTEMS
Novel photographic method of recording images from cellulose nitrate film, 5:24579
DAUGHTER PRODUCTS/DOSIMETRY
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)
DC SYSTEMS/RESEARCH PROGRAMS
dc Superconducting Power Transmission Line project at LASL: US DOE Division of Electric Energy Systems. Progress report No. 24, November 1, 1972-September 30, 1979. Final report, 5:24041 (LA—8323-PR)
DC SYSTEMS/SUPERCONDUCTING CABLES
dc Superconducting Power Transmission Line project at LASL: US DOE Division of Electric Energy Systems. Progress report No. 24, November 1, 1972-September 30, 1979. Final report, 5:24041 (LA—8323-PR)
DC TO AC INVERTERS
See INVERTERS
DDT
(Dichlorodiphenyltrichloroethane.)
DDT/SURFACE CONTAMINATION
Compartmentalization of ^{14}C-DDT in an experimental old-field plot, 5:24644
DECISION MAKING
Remarks on the assessment, representation, aggregation and utilization of expert opinion, 5:23749 (UCID—18665)
DECISION MAKING/MATHEMATICAL MODELS
Formal analysis including value judgments and public risk, 5:24186 (UCRL—15226)
DECONTAMINATION/TIME DEPENDENCE
Metabolism of americium-241 in man: an unusual case of internal contamination of a child and his father, 5:24752 (COO—3382-18)
DEER/TISSUE DISTRIBUTION
Metals in soft tissues of mule deer and antelope, 5:24775
DEFORMED NUCLEI/ALPHA DECAY
Decay of deformed and superdeformed nuclei formed in heavy ion reactions, 5:24910
DEMONSTRATION PLANTS
See also INDUSTRIAL PLANTS
DEMONSTRATION PLANTS/DESIGN
Pipeline gas demonstration plant. Phase I. Quarterly technical progress report, September-November 1979, 5:23422 (FE—2012-083)
DEMONSTRATION PLANTS/OPERATION
Status of the Texaco coal dust gasification operating in the Ruhrchemie/Ruhrkohle demonstration plant at Oberhausen-Holten, 5:23437
DEMONSTRATION PLANTS/OPTIMIZATION
Status of the Texaco coal dust gasification operating in the Ruhrchemie/Ruhrkohle demonstration plant at Oberhausen-Holten, 5:23437
DENSIMETERS/CONTROL SYSTEMS
Microprocessor-controlled scanning densitometer system, 5:24565 (DOE/ID/01570—T4)
DENSIMETERS/RELIABILITY
Microprocessor-controlled scanning densitometer system, 5:24565 (DOE/ID/01570—T4)
DEOXYPENTOSE NUCLEIC ACID
See DNA
DEOXYRIBONUCLEIC ACID
See DNA
DEPOSITION
See also SURFACE COATING
DEPOSITION/VELOCITY
Estimated dry deposition velocities of sulfur over the eastern United States and surrounding regions, 5:24627
DESOXYRIBONUCLEIC ACID
See DNA
DETONATION WAVES
See SHOCK WAVES
DETONATIONS/VELOCITY
Effect of a chemical inhomogeneity on steady-state detonation velocity, 5:24585
DEUTERIUM/DIFFUSION
Ion beam technique for the measurement of deuterium diffusion coefficients, 5:24359
DEUTERIUM/LASER ISOTOPE SEPARATION
Deuterium separation at high pressure by nanosecond CO_2 laser multiple-photon dissociation, 5:24497
DEUTERIUM COMPOUNDS
See also DEUTERIUM TRITIDES
DEUTERIUM COMPOUNDS/CRYSTAL STRUCTURE
Neutron diffraction study of quinolinic acid recrystallized from D_2O: evaluation of temperature and isotope effects in the structure, 5:24460
DEUTERIUM IONS/COLLISIONS
Retention and re-emission of 0.125— 1-keV deuterium in stainless steel, 5:24808
DEUTERIUM TARGET/DEUTERON REACTIONS
Comparison of analyzing powers and polarizations for the charge symmetric reactions ^{2}H(d,p)^{3}H and ^{2}H(d,n)^{3}He, 5:24888
Low-energy nuclear fusion data and their relation to magnetic and laser fusion, 5:24890 (LA—8087)
DEUTERIUM TARGET/PROTON REACTIONS
Proton-deuteron elastic scattering at 800 MeV, 5:24891
DEUTERIUM TRITIDES/IMPLOSIONS
Space-time energy concentration and the design of DT fusion micro-explosions, 5:25077 (UCRL—81919)
DEUTERON REACTIONS/COMPOUND-NUCLEUS REACTIONS
Low-energy nuclear fusion data and their relation to magnetic and laser fusion, 5:24890 (LA—8087)
DEUTERON REACTIONS/STRIPPING
Comparison of analyzing powers and polarizations for the charge symmetric reactions ^{2}H(d,p)^{3}H and ^{2}H(d,n)^{3}He, 5:24888
Description of direct nuclear rearrangement reactions using various coupled channel equations, 5:24946
Low-energy nuclear fusion data and their relation to magnetic and laser fusion, 5:24890 (LA—8087)
DEUTERON-DEUTERON INTERACTIONS
See DEUTERIUM TARGET DEUTERON REACTIONS
DEVELOPING COUNTRIES/ENERGY POLICY
Framework for energy policy and technology assessment in developing countries: a case study of Peru, 5:24200 (BNL—27613)
DEVELOPING COUNTRIES/ENERGY SUPPLIES
Global perspective on energy (Projecting into 21st century), 5:24193 (CONF-800403—43)
DEVELOPING COUNTRIES/TECHNOLOGY ASSESSMENT
Framework for energy policy and technology assessment in developing countries: a case study of Peru, 5:24200 (BNL—27613)
DHDECMP/PURIFICATION
Purification of dihexyl N,N-diethylcarbamylmethylenephosphonate by mercury (II) precipitation, 5:23718 (ENICO—1026)
DIAL PAINTERS/PERSONNEL MONITORING
Long-term effects of radium exposure in female dial workers: liver function and liver disease, 5:24778
DIAPHRAGMS (THERMONUCLEAR DEVICE)
See LIMITERS
1,3-DIAZINES
See PYRIMIDINES
1,4-DIAZINES
See PYRAZINES

DICHLORODIPHENYLTRICHLOROETHANE
See DDT
DIENES/SEPARATION PROCESSES
Hydrotreating of pyrolysis gasoline (Patent), 5:23594
DIESEL ENGINES/BOTTOMING CYCLES
Design study of a two-phase turbine bottoming cycle. Final report (Therminol 66 heated in diesel exhaust), 5:24309 (DOE/ET/15350—T1)
DIESEL ENGINES/EXHAUST GASES
Control technology for diesel equipment in the underground mining environment - a review of selected topics. Final report 23 August 1978-31 January 1979, 5:24520 (PB—299946)
Diesel hydrocarbon measurement - series filter test. Technical report, 5:24356 (PB—301410)
Investigation of the effects of the installation of an oxidation catalyst on a diesel powered vehicle. Technical report, 5:24351 (PB—299928)
Performance of a diesel engine operating on raw coal-diesel fuel and solvent refined coal-diesel fuel slurries. Final report, 5:24335 (CONS—3288-T6)
DIESEL ENGINES/FUEL ECONOMY
Investigation of the effects of the installation of an oxidation catalyst on a diesel powered vehicle. Technical report, 5:24351 (PB—299928)
DIESEL ENGINES/FUEL SUBSTITUTION
Economic and technological assessment of diesel engines using coal-based fuels for electric power generation. Final report, 5:24336 (TE—4234-37-80)
DIESEL ENGINES/PERFORMANCE
Investigation of the effects of the installation of an oxidation catalyst on a diesel powered vehicle. Technical report, 5:24351 (PB—299928)
Performance of a diesel engine operating on raw coal-diesel fuel and solvent refined coal-diesel fuel slurries. Final report, 5:24335 (CONS—3288-T6)
DIESEL ENGINES/POLLUTION CONTROL EQUIPMENT
Control technology for diesel equipment in the underground mining environment - a review of selected topics. Final report 23 August 1978-31 January 1979, 5:24520 (PB—299946)
DIESEL ENGINES/WASTE HEAT
Design study of a two-phase turbine bottoming cycle. Final report (Therminol 66 heated in diesel exhaust), 5:24309 (DOE/ET/15350—T1)
DIESEL FUELS/FIRE PREVENTION
Fire-safe hydrocarbon fuels (Patent), 5:23599
DIESEL FUELS/HEALTH HAZARDS
Evaluation of comparative toxicity and shipboard hazards of selected petroleum and oil shale-derived fuels, 5:23655
DIETHYLENETRIAMINEPENTAACETIC ACID
See DTPA
DIFFERENTIAL EQUATIONS
See also FOKKER-PLANCK EQUATION
KORTEWEG-DE VRIES EQUATION
WAVE EQUATIONS
DIFFERENTIAL EQUATIONS/NUMERICAL SOLUTION
A-posteriori error estimates for the finite element method, 5:25115
Numerical methods for a general class of porous medium equations, 5:24974 (ANL—80-39)
DIFFRACTION
See also ELECTRON DIFFRACTION
DIFFRACTION/INTEGRAL EQUATIONS
Exact solutions in the scalar diffraction theory of aberrations, 5:24972
DIFFUSION/MATHEMATICAL MODELS
Numerical methods for a general class of porous medium equations, 5:24974 (ANL—80-39)
DIMERS/STRUCTURAL CHEMICAL ANALYSIS
Interactions of 4-nitroquinoline 1-oxide with deoxyribodinucleotides, 5:24679
DIMETHYLKETONE
See ACETONE
DIODES (SEMICONDUCTOR)
See SEMICONDUCTOR DIODES
DIOLS
See GLYCOLS
DIRAC MONOPOLES
See MAGNETIC MONOFOLES
DIRECT REACTIONS/COUPLED CHANNEL THEORY
Description of direct nuclear rearrangement reactions using various coupled channel equations, 5:24946
DISASTERS/EMERGENCY PLANS
Natural Hazards Observer, volume 2, number 4, June 1978, 5:25117 (PB—300976)
DISCHARGING (REACTOR)
See REACTOR FUELING
DISEASE RESISTANCE/GENETIC CONTROL
Race-specific molecules that protect soybeans from Phytophthora megasperma var. sojae, 5:24728
DISK MHD GENERATORS/FLOW MODELS
MHD generator modeling, 5:24228 (FE—2215-13(Vol.2))
DISK MHD GENERATORS/PERFORMANCE
Studies in a disk generator, 5:24220 (FE—2215-13(Vol.2))
DISK MHD GENERATORS/PLASMA DIAGNOSTICS
Studies in a disk generator, 5:24220 (FE—2215-13(Vol.2))
DISPERSANTS (CHEMICAL)
See SURFACTANTS
DISTRIBUTED COLLECTOR POWER PLANTS/CAVITY RECEIVERS
Reliability and durability study of a thermal receiver utilizing ASI Type 316 stainless steel in contact with molten aluminum, 5:23860 (SERI/TP—641-653)
DISTRIBUTED COLLECTOR POWER PLANTS/DEMONSTRATION PROGRAMS
Point-Cocusing Thermal and Electric Applications Project. Annual technical report, fiscal year 1979. Volume I. Executive summary. JPL Publication 79-118, Volume I, 5:23859 (DOE/JPL—1060-31)
DISTRIBUTED COLLECTOR POWER PLANTS/RESEARCH PROGRAMS
Point-Cocusing Thermal and Electric Applications Project. Annual technical report, fiscal year 1979. Volume I. Executive summary. JPL Publication 79-118, Volume I, 5:23859 (DOE/JPL—1060-31)
DISTRIBUTED COLLECTOR POWER PLANTS/TEST FACILITIES
Solar total energy project at the Sandia Laboratories Midtemperature Solar Systems Test Facility (MSSTF), 5:23861 (SERI/TP—333-429)
DISTRICT COOLING/ECONOMICS
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume I. Text, 5:24322 (COO—4975-(Vol.1)(Text))
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume II. Appendices, 5:24325 (COO—4975-1(Vol.2)(App.))
DISTRICT COOLING/FEASIBILITY STUDIES
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume I. Text, 5:24322 (COO—4975-(Vol.1)(Text))
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume II. Appendices, 5:24325 (COO—4975-1(Vol.2)(App.))
DISTRICT COOLING/LEGAL ASPECTS
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume I. Text, 5:24322 (COO—4975-(Vol.1)(Text))
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume II. Appendices, 5:24325 (COO—4975-1(Vol.2)(App.))
DISTRICT HEATING/ECONOMICS
District heating and cooling system for communities through power plant retrofit and distribution network. Final report, Phase I, 5:24323 (COO—4980-1)
District heating and cooling through power plant retrofit and distribution network. Final report. Phase 1, executive summary, 5:24324 (COO—4980-1(Exec.Summ.))
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume I. Text, 5:24322 (COO—4975-(Vol.1)(Text))
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume II. Appendices, 5:24325 (COO—4975-1(Vol.2)(App.))
DISTRICT HEATING/FEASIBILITY STUDIES
District heating and cooling system for communities through power plant retrofit and distribution network. Final report, Phase I, 5:24323 (COO—4980-1)
District heating and cooling through power plant retrofit and distribution network. Final report. Phase 1, executive summary, 5:24324 (COO—4980-1(Exec.Summ.))
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume I. Text, 5:24322 (COO—4975-(Vol.1)(Text))
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume II. Appendices, 5:24325 (COO—4975-1(Vol.2)(App.))
Feasibility of a large district heating-cogeneration system for the Minneapolis-St. Paul area, 5:24189 (CONF-7910156—2)
DISTRICT HEATING/LEGAL ASPECTS
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume I. Text, 5:24322 (COO—4975-(Vol.1)(Text))
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume II. Appendices, 5:24325 (COO—4975-1(Vol.2)(App.))

DISTRICT HEATING/THERMAL ENERGY STORAGE EQUIPMENT
Evaluation of thermal energy storage for a large urban hot water district heating system in the United States, 5:24101 (CONF-7910152—1)
DIVERTORS
See also PDX DEVICES
DIVERTORS/CRYOPUMPS
Direct cryosorption pumping of an energetic hydrogen ion beam, 5:25087 (CONF-791102—171)
DNA
(Deoxyribonucleic acid.)
DNA/BIOCHEMISTRY
Actinomycin D-deoxynucleotide interactions: binding isotherms at the benzenoid and quinoid portions of the drug, 5:24692
DNA/BIOLOGICAL EFFECTS
Repair of ultraviolet light damage to the DNA of cultured human epidermal keratinocytes and fibroblasts, 5:24742
DNA/BIOLOGICAL REPAIR
Analysis of the effects of chemical and physical mutagens on subchromosomal DNA synthesis in cultured mammalian cells (X rays; uv radiation; MMS), 5:24736 (UR—3490/LCP-20)
Deoxyribonucleic acid excision repair in chromatin after ultraviolet irradiation of human fibroblasts in culture, 5:24741
Production and excision of thymine damage in the DNA of mammalian cells exposed to high-LET radiations, 5:24737
DNA/BIOSYNTHESIS
Fidelity of fractionated deoxyribonucleic acid polymerases from human placenta, 5:24696
DNA/HYBRIDIZATION
Transcription of yeast mitochondrial deoxyribonucleic acid, 5:24684
DNA/TOLERANCE
Dependence of mammalian DNA replication on DNA supercoiling. I. Effects of ethidium bromide on DNA synthesis in permeable Chinese hamster ovary cells, 5:24691
DNA/TRANSCRIPTION
Transcription of yeast mitochondrial deoxyribonucleic acid, 5:24684
DNA REPLICATION/BIOLOGICAL PATHWAYS
Fidelity of fractionated deoxyribonucleic acid polymerases from human placenta, 5:24696
DNA REPLICATION/BIOLOGICAL RADIATION EFFECTS
Analysis of the effects of chemical and physical mutagens on subchromosomal DNA synthesis in cultured mammalian cells (X rays; uv radiation; MMS), 5:24736 (UR—3490/LCP-20)
DNA REPLICATION/INHIBITION
Analysis of the effects of chemical and physical mutagens on subchromosomal DNA synthesis in cultured mammalian cells (X rays; uv radiation; MMS), 5:24736 (UR—3490/LCP-20)
Dependence of mammalian DNA replication on DNA supercoiling. II. Effects of novobiocin on DNA synthesis in Chinese Hamster ovary cells, 5:24700
DOLOMITE/SHOCK WAVES
Shock wave studies in Blair dolomite, 5:24793
DOSE COMMITMENTS/COMPUTER CODES
PABLM: a computer program to calculate accumulated radiation doses from radionuclides in the environment, 5:24754 (PNL—3209)
DOSE EQUIVALENTS/MATHEMATICAL MODELS
Calculation of dose-rate conversion factors for external exposure to photons and electrons, 5:24953 (CONF-7810133—6)
DOSE RATES/IONIZING RADIATIONS
Calculation of dose-rate conversion factors for external exposure to photons and electrons, 5:24953 (CONF-7810133—6)
DOSIMETRY
See also PION DOSIMETRY
DOSIMETRY/COMPUTER CALCULATIONS
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)
DRAG EFFECT
See ELECTROPHORESIS
DRIFT INSTABILITY/NONLINEAR PROBLEMS
Simulation of drift-cone modes, 5:25029
DRIFT INSTABILITY/TRAPPING
Simulation of drift-cone modes, 5:25029
DRILL CORES/SCANNING ELECTRON MICROSCOPY
Secondary minerals found in the cores DC2 A1 and DC2 A2 taken from the Grande Ronde Basalt Formation, Pasco Basin, Washington, 5:23730 (LBL—10387)
DRILL CORES/X-RAY DIFFRACTION
Secondary minerals found in the cores DC2 A1 and DC2 A2 taken from the Grande Ronde Basalt Formation, Pasco Basin, Washington, 5:23730 (LBL—10387)
DRILLING FLUIDS/LUBRICANTS
Aqueous drilling fluid and lubricant composition (Patent), 5:23580
DRILLING MUD
See DRILLING FLUIDS
DRILLING PLATFORMS
See OFFSHORE PLATFORMS
DRINKING WATER/CHLORINATION
Oxidation techniques in Drinking water treatment. drinking water pilot project. Report IIa. Advanced treatment technology. Final report, 5:24666 (PB—301313)
DRINKING WATER/WATER POLLUTION CONTROL
Oxidation techniques in Drinking water treatment. drinking water pilot project. Report IIa. Advanced treatment technology. Final report, 5:24666 (PB—301313)
DROSOPHILA/MUTATION FREQUENCY
Frequency-dependent selection at the PGM-1 locus of Drosophila pseudoobscura, 5:24713
DRY DEPOSITION
See DEPOSITION
DRYERS
See also SOLAR DRYERS
DRYERS/WASTE HEAT
Demonstration of energy conservation for multi-deck board dryers. Phase I. Final report, 5:24307 (DOE/CS/40167—T1)
DRYING
See also SOLAR DRYING
Role of seed particles in the prediction and control of product particle size in fluidized-bed dryers, 5:23719 (ENICO—1036)
DTPA
(Diethylenetriaminepentaacetic acid.)
DTPA/BIOLOGICAL EFFECTS
Curium-243,4 in the tissues of the adult baboon (Time-dependent effects of DTPA administration on excretion), 5:24757 (COO—3382-18)
Metabolism of americium-241 in man: an unusual case of internal contamination of a child and his father, 5:24752 (COO—3382-18)
DTPA/DETONATIONS
Effect of a chemical inhomogeneity on steady-state detonation velocity, 5:24585
DUSTS/AGGLOMERATION
Method of agglomerating fine powders (Patent), 5:23514
DUSTS/MONITORING
Improved light scattering dust monitor. Open file report (final) 3 August 1977-31 May 1978, 5:24569 (PB—299938)
DUSTS/PELLETIZING
Grain-dust pelleting costs and capital requirements for stationary and portable plants, 5:23793 (PB—300690)
DUSTS/SAMPLING
Development of an area sampling methodology. Open file report (final) June 73-October 1975, 5:23523 (PB—299926)
DYES
See also ACRIDINE ORANGE
PHTHALOCYANINES
DYES/TOXICITY
Dependence of mammalian DNA replication on DNA supercoiling. I. Effects of ethidium bromide on DNA synthesis in permeable Chinese hamster ovary cells, 5:24691
DYSPROSIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
DYSPROSIUM 152/E2-TRANSITIONS
Single particle nature of the yrast line at high angular momentum in ^{152}Dy, 5:24923
DYSPROSIUM 152/HIGH SPIN STATES
Single particle nature of the yrast line at high angular momentum in ^{152}Dy, 5:24923
DYSPROSIUM 152/YRAST STATES
Is there evidence for rotation along the axis of symmetry in transitional nuclei, 5:24919
Single particle nature of the yrast line at high angular momentum in ^{152}Dy, 5:24923
DYSPROSIUM 164 TARGET/ALPHA REACTIONS
High-spin properties of ^{164}Er in the multiple band crossing region, 5:24922

E

EARTH ATMOSPHERE
See also IONOSPHERE
EARTH ATMOSPHERE/RADIONUCLIDE MIGRATION
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)

User's manual for DWNWND: an interactive Gaussian plume atmospheric transport model with eight dispersion parameter options, 5:24633 (ORNL/TM—6874)
EARTHQUAKES/FORECASTING
Microzonation for safer construction-research and application. Proceedings of International Conference (2nd), held at San Francisco, California on November 26-December 1, 1978. Volume I, 5:24783 (PB—301144)
EARTHQUAKES/GROUND MOTION
Microzonation for safer construction-research and application. Proceedings of International Conference (2nd), held at San Francisco, California on November 26-December 1, 1978. Volume I, 5:24783 (PB—301144)
E-BEAM TYPE REACTORS/NEUTRON REACTIONS
Pellet ad pellet-blanket neutronics and photonics for electron beam fusion, 5:25083
EBR-2 REACTOR/STEAM GENERATORS
Ultrasonic inspection of liquid-metal fast breeder reactor steam generator duplex tubing, 5:24063
ECCS
(Emergency core cooling system.)
ECCS/PIPES
Unique rod lens/video system designed to observe flow conditions in emergency core coolant loops of pressurized water reactors, 5:24048 (UCRL—52902)
ECCS/TEST FACILITIES
Unique rod lens/video system designed to observe flow conditions in emergency core coolant loops of pressurized water reactors, 5:24048 (UCRL—52902)
ECOLOGICAL COMMUNITIES
See ECOSYSTEMS
ECONOMIC ANALYSIS
Quadratic programming and spatial equilibrium: the case of coal. Program working papers, 5:23566 (PB—301365)
ECONOMIC GROWTH
Conservation and the changing direction of economic growth (Book; 6 papers), 5:24199
ECOSYSTEMS
See also AQUATIC ECOSYSTEMS
ECOSYSTEMS/INFORMATION SYSTEMS
Monitoring on rights-of-way and the National Biomonitoring Inventory, 5:24642 (CONF-7910141—1)
ECR HEATING/COMPUTERIZED SIMULATION
Numerical simulation of magnetically confined plasmas undergoing cyclotron resonance heating, 5:24991
ECR HEATING/MICROWAVE AMPLIFIERS
Heating at the electron cyclotron frequency in the ISX-B tokamak, 5:24988
Theory of electron cyclotron resonance heating of tokamak plasmas, 5:24984
EDDY CURRENTS
(Limited to electric currents.)
EDDY CURRENTS/ANALYTICAL SOLUTION
Eddy current heating of irregularly shaped plates by slow ramped fields, 5:25048 (CONF-791102—167)
EFFLUENTS (CHEMICAL)
See CHEMICAL EFFLUENTS
EHRLICH ASCITES TUMOR/RADIOSENSITIVITY
Oxygen effect and adaptive reactions of cells. Report 2. Kinetics of respiration of tumor cells differing in initial respiration level (γ rays; Ehrlich ascites tumor cells), 5:24747
EHRLICH ASCITES TUMOR/RESPIRATION
Oxygen effect and adaptive reactions of cells. Report 2. Kinetics of respiration of tumor cells differing in initial respiration level (γ rays; Ehrlich ascites tumor cells), 5:24747
EINSTEIN-DE SITTER MODEL
See COSMOLOGICAL MODELS
ELDERLY PEOPLE/FEDERAL ASSISTANCE PROGRAMS
Crisis intervention programs in Federal Region III: a policy perspective, 5:24180 (PB—300758)
ELECTRIC BATTERIES
(Devices for production and/or storage of electrical energy from chemical reactions; excludes FUEL CELLS and RADIOISOTOPE BATTERIES.)
See also LEAD-ACID BATTERIES
METAL-METAL BATTERIES
METAL-METAL OXIDE BATTERIES
METAL-NONMETAL BATTERIES
THERMAL BATTERIES
ELECTRIC BATTERIES/MANUALS
Handbook for battery energy storage photovoltaic power systems. Final report, 5:23851 (SAN—2192-T1)
ELECTRIC BATTERIES/MEETINGS
Twenty-eighth power sources symposium (Atlantic City, NJ, June 12-15, 1978), 5:24102
ELECTRIC BATTERIES/PERFORMANCE
Batteries for auxiliary electrical supplies in aircraft, 5:24172
Handbook for battery energy storage photovoltaic power systems. Final report, 5:23851 (SAN—2192-T1)
ELECTRIC BATTERIES/PERFORMANCE TESTING
BEST Facility: accelerating the development of utility load-leveling batteries, 5:24163
ELECTRIC BATTERIES/VOLTAGE REGULATORS
Voltage regulator for battery power source, 5:24157
ELECTRIC CABLES
See also SUPERCONDUCTING CABLES
ELECTRIC CABLES/CONTAINERS
Cable tray fire tests, 5:24446 (EPRI-EL—1263)
ELECTRIC CABLES/ELECTRICAL INSULATION
Fire retardant polymers in electrical wire and cable, 5:24449 (EPRI-EL—1263)
Overview and summary, 5:24448 (EPRI-EL—1263)
Review of the approaches to improving the flame resistance of wire and cable insulating and jacketing materials, 5:24447 (EPRI-EL—1263)
Use of x-ray fluorescence spectral analysis in material characterization for quality control, 5:24531 (EPRI-EL—1263)
ELECTRIC CABLES/FIRE PREVENTION
Minimizing fire potential in power plant cable systems, 5:24074 (EPRI-EL—1263)
Special reporter comments and questions, 5:24075 (EPRI-EL—1263)
ELECTRIC CABLES/FIRE RESISTANCE
Overview and summary, 5:24448 (EPRI-EL—1263)
ELECTRIC CABLES/POLYMERS
Cable tray fire tests, 5:24446 (EPRI-EL—1263)
Fire retardant polymers in electrical wire and cable, 5:24449 (EPRI-EL—1263)
ELECTRIC CABLES/STANDARDS
Overview and summary, 5:24448 (EPRI-EL—1263)
ELECTRIC CABLES/TESTING
Cable tray fire tests, 5:24446 (EPRI-EL—1263)
ELECTRIC CONTACTORS
See SWITCHES
ELECTRIC CONTACTS/EVAPORATION
Barrier heights of evaporated metal contacts on Zn_3P_2, 5:24474
ELECTRIC CONTACTS/POWER SUPPLIES
Contacts for pulsed high current: design and test, 5:25053
ELECTRIC CONTACTS/SCREEN PRINTING
Overview of thick-film technology as applied to solar cells, 5:23821 (SERI/TP—331-541)
ELECTRIC FUSES
Preliminary inductive energy transfer experiments, 5:25060
ELECTRIC GENERATORS
(Rotating generators only; excludes DIRECT ENERGY CONVERTERS.)
ELECTRIC GENERATORS/DESIGN
Rebuilding the five megajoule homopolar machine at the university of texas, 5:25057
ELECTRIC GENERATORS/ELECTRICAL TESTING
Testing and analysis of a fast discharge homopolar machine (fdx), 5:25059
ELECTRIC GENERATORS/MATHEMATICAL MODELS
Computer based electrical analysis of homopolar generator driven, bitter plate storage inductors with radial current diffusion, 5:25058
ELECTRIC GROUNDS
Safety grounding switches in large experiments; general considerations and the TEXT application, 5:25061
ELECTRIC MOTORS/TECHNOLOGY ASSESSMENT
Vehicle longitudinal control and reliability project. A review of AGT propulsion, power conditioning, braking and power distribution technology. Final report, 5:24346 (PB—300373)
ELECTRIC POWER/COST
An investigation of preferences for various types of energy cost feedback. Final report, 5:24212 (PB—300314)
ELECTRIC POWER/FREQUENCY CONTROL
Multifrequency factory operations. Final report, 5:24303 (SAN—1731-T3)
ELECTRIC POWER INDUSTRY/FINANCIAL INCENTIVES
Analysis of federal incentives used to stimulate energy production: an executive summary, 5:24182 (PNL—2410(Rev.2))
ELECTRIC RAILWAYS
See also ELECTRIC-POWERED VEHICLES
RAPID TRANSIT SYSTEMS
ELECTRIC RAILWAYS/CONTROL SYSTEMS
Vehicle longitudinal control and reliability project. A review of AGT propulsion, power conditioning, braking and power distribution technology. Final report, 5:24346 (PB—300373)
ELECTRIC RAILWAYS/ECONOMIC ANALYSIS
Agt guideway and station technology. Volume 8. Weather protection concepts. Final report, 5:24343 (PB—299746)
ELECTRIC RAILWAYS/ELECTRIC MOTORS
Vehicle longitudinal control and reliability project. A review of AGT propulsion, power conditioning, braking and power distribution technology. Final report, 5:24346 (PB—300373)

ELECTRIC RAILWAYS/ENERGY CONSUMPTION
Agt guideway and station technology. Volume 8. Weather protection concepts. Final report, 5:24343 (PB—299746)
ELECTRIC RAILWAYS/OPERATION
Agt guideway and station technology. Volume 8. Weather protection concepts. Final report, 5:24343 (PB—299746)
ELECTRIC SWITCHES
See SWITCHES
ELECTRIC UTILITIES
Electric utilities and residential solar systems, 5:23877 (BNL—27711)
ELECTRIC UTILITIES/CAPACITY
Literature review on capacity expansion planning under uncertainty. Phase II, 5:24211 (DOE/TIC—11177)
ELECTRIC UTILITIES/ENVIRONMENTAL IMPACTS
Analysis of environmental factors affecting technology deployment: a case study, 5:24027 (DOE/RA/10001—T1)
ELECTRIC UTILITIES/FUEL SUBSTITUTION
Powerplant and Industrial Fuel Use Act: annual report, 5:24203 (DOE/RG—0028)
ELECTRIC UTILITIES/INVESTMENT
Literature review on capacity expansion planning under uncertainty. Phase II, 5:24211 (DOE/TIC—11177)
ELECTRIC UTILITIES/MARKET
Analysis of environmental factors affecting technology deployment: a case study, 5:24027 (DOE/RA/10001—T1)
ELECTRIC UTILITIES/OCEAN THERMAL POWER PLANTS
Description of the system planning process at Florida Power Corporation. Task I. Report No. FC-5237-1, 5:23867 (DOE/ET/29187—T3)
ELECTRIC UTILITIES/REGULATIONS
Overview report: experiment in computer applications for regulatory agencies. Final report, 5:24213 (PB—300770)
ELECTRIC UTILITIES/TECHNOLOGY UTILIZATION
Overview report: experiment in computer applications for regulatory agencies. Final report, 5:24213 (PB—300770)
ELECTRIC UTILITIES/TIME-OF-USE PRICING
Electricity demand and consumption by time-of-use: a survey. Final report, 5:24197 (EPRI-AF—1294)
ELECTRICAL INSULATION/ELECTRICAL PROPERTIES
Fire retardant polymers in electrical wire and cable, 5:24449 (EPRI-EL—1263)
ELECTRICAL INSULATION/FIRE RESISTANCE
Overview and summary, 5:24448 (EPRI-EL—1263)
ELECTRICAL INSULATION/MEETINGS
Flammability of solid polymer cable dielectrics. Final report, 5:24440 (EPRI-EL—1263)
ELECTRICAL INSULATION/QUALITY CONTROL
Use of x-ray fluorescence spectral analysis in material characterization for quality control, 5:24531 (EPRI-EL—1263)
ELECTRICAL INSULATION/STANDARDS
Overview and summary, 5:24448 (EPRI-EL—1263)
ELECTRICAL INSULATION/WASTE DISPOSAL
Delicate disposal of PCBs, 5:24030
ELECTRICAL INSULATORS/DESIGN
Joint US-USSR test of the US MHD electrode system in the U-02 facility, Phase III. Final report, 5:24221 (FE—2248-23)
ELECTRICAL INSULATORS/MATERIALS TESTING
Joint US-USSR test of the US MHD electrode system in the U-02 facility, Phase III. Final report, 5:24221 (FE—2248-23)
ELECTRIC-POWERED VEHICLES
See also ELECTRIC RAILWAYS
ELECTRIC-POWERED VEHICLES/ALUMINIUM-AIR BATTERIES
Control system considerations for an aluminum-air battery powered electric vehicle. Final report, 5:24348 (UCRL—15241)
ELECTRIC-POWERED VEHICLES/CONTROL SYSTEMS
Control system considerations for an aluminum-air battery powered electric vehicle. Final report, 5:24348 (UCRL—15241)
ELECTRIC-POWERED VEHICLES/ECONOMIC ANALYSIS
Study of hydrogen-powered versus battery-powered automobiles, 5:24341 (ATR—79(7759)-(Vol.2))
ELECTRIC-POWERED VEHICLES/ENERGY CONSUMPTION
Simulation of an urban battery bus vehicle. Final report June-December 1978, 5:24345 (PB—300306)
ELECTRIC-POWERED VEHICLES/IRON-AIR BATTERIES
Iron-air battery characteristics, 5:24114
ELECTRIC-POWERED VEHICLES/IRON-NICKEL BATTERIES
Performance characteristics of iron nickel batteries (109 kWh, 132 V), 5:24136
ELECTRIC-POWERED VEHICLES/LEAD-ACID BATTERIES
Simulation of an urban battery bus vehicle. Final report June-December 1978, 5:24345 (PB—300306)
ELECTRIC-POWERED VEHICLES/LIFE-CYCLE COST
Hybrid vehicle potential assessment. Volume 10. Electric and hybrid vehicle cost handbook, 5:24342 (CONS—4209-T1(Vol.10))
ELECTRIC-POWERED VEHICLES/LITHIUM-SULFUR BATTERIES
Development of advanced batteries at Argonne National Laboratory. Summary report for 1979, 5:24103 (ANL—80-32)
ELECTRIC-POWERED VEHICLES/LITHIUM-WATER-AIR BATTERIES
Development of a lithium-water-air battery (To be mechanically rechargeable), 5:24119
ELECTRIC-POWERED VEHICLES/OPERATING COST
Hybrid vehicle potential assessment. Volume 10. Electric and hybrid vehicle cost handbook, 5:24342 (CONS—4209-T1(Vol.10))
ELECTRIC-POWERED VEHICLES/PERFORMANCE
Simulation of an urban battery bus vehicle. Final report June-December 1978, 5:24345 (PB—300306)
ELECTRIC-POWERED VEHICLES/SODIUM-SULFUR BATTERIES
Current status of the hollow fiber sodium-sulfur cell (0.5- and 5-Ah), 5:24124
ELECTRIC-POWERED VEHICLES/TECHNOLOGY ASSESSMENT
Study of hydrogen-powered versus battery-powered automobiles, 5:24341 (ATR—79(7759)-(Vol.2))
Study of hydrogen-powered versus battery-powered automobiles, 5:24340 (ATR—79(7759)-1(Vol.3))
ELECTRIC-POWERED VEHICLES/ZINC-CHLORINE BATTERIES
50 kW-hr zinc-chlorine hydrate battery, 5:24106
ELECTROCATALYSTS/FABRICATION
New H_3PO_4 fuel cell electrocatalysts made from alumina/pyropolymer composites, 5:24241
ELECTROCATALYSTS/PERFORMANCE
New H_3PO_4 fuel cell electrocatalysts made from alumina/pyropolymer composites, 5:24241
ELECTROCATALYSTS/POISONING
Diagnostic techniques for performance evaluation of fuel cells. I. Comparison of carbon monoxide tolerance of selected anodes, 5:24239
ELECTROCHEMICAL CELLS
See also ELECTRIC BATTERIES
FUEL CELLS
PHOTOELECTROCHEMICAL CELLS
ELECTROCHEMICAL CELLS/DESIGN
Portable probe to measure sensitization of stainless steel (Patent), 5:24417
ELECTROCHEMICAL CELLS/PROBES
Portable probe to measure sensitization of stainless steel (Patent), 5:24417
ELECTRODES
See also ANODES
CATHODES
ELECTRODES/DESIGN
Joint US-USSR test of the US MHD electrode system in the U-02 facility, Phase III. Final report, 5:24221 (FE—2248-23)
ELECTRODES/MATERIALS TESTING
Electrode module materials evaluation, 5:24223 (FE—2215-13(Vol.1))
Electrode module development, 5:24225 (FE—2215-13(Vol.1))
Joint US-USSR test of the US MHD electrode system in the U-02 facility, Phase III. Final report, 5:24221 (FE—2248-23)
ELECTROMAGNETIC SURVEYS
See also MAGNETOTELLURIC SURVEYS
ELECTROMAGNETIC SURVEYS/ACCURACY
Cross-borehole electromagnetic probing to locate high-constrast anomalies, 5:24787
ELECTROMAGNETIC TRANSITIONS
See ENERGY-LEVEL TRANSITIONS
ELECTRON BEAM TARGETS/NEUTRON REACTIONS
Pellet ad pellet-blanket neutronics and photonics for electron beam fusion, 5:25083
ELECTRON BEAM TYPE REACTORS
See E-BEAM TYPE REACTORS
ELECTRON BEAMS/BEAM OPTICS
Optimization of a synchrotron radiation source, 5:24556 (BNL—27654)
ELECTRON BEAMS/CALIBRATION
Absorbed dose measurements using parallel plate polystyrene ionization chambers in polystyrene phantoms, 5:24954
ELECTRON CYCLOTRON-RESONANCE H
See ECR HEATING
ELECTRON DIFFRACTION/KIKUCHI LINES
Indexing of diffracting planes using the Kikuchi pattern, 5:24384
ELECTRON EMISSION/CURRENT DENSITY
Obtaining numerical values for the elliptic emission functions used in calculating electron emission from surfaces, 5:24957

ELECTRON MICROSCOPY/IMAGE PROCESSING
Overview of image reconstruction, 5:25105 (BNL—27665)
ELECTRON REACTIONS/INELASTIC SCATTERING
Investigation of natural-parity high-spin states in ^{208}Pb by (e,e') reactions, 5:24931
ELECTRON TUBES/ELECTRICAL TESTING
High power very long pulse testing of a 200 kv. tetrode regulation tube, 5:25055
ELECTRONIC DATA PROCESSING
See DATA PROCESSING
ELECTRONIC EQUIPMENT
See also MICROWAVE EQUIPMENT
OPTICAL SCANNERS
POWER SUPPLIES
ELECTRONIC EQUIPMENT/FABRICATION
Quartz crystal fabrication facility. Phase I. Final report, April 1977-September 1979, 5:24537 (GEPP-FR—434)
ELECTRON-ION COLLISIONS/IONIZATION
Absolute experimental cross sections for the electron impact ionization of rubidium. Technical summary report, 5:24820 (ORO—3027-52)
ELECTRON-POSITRON INTERACTIONS/ANNIHILATION
Background to neutrino counting in e^+e^- collisions, 5:24859
Decay $J/\pi \rightarrow 3\gamma$ and a search for the eta/sub c/, 5:24842
Process dependence of perturbative quantum-chromodynamic jet structures, 5:24884
Recent results from the crystal ball detector at SPEAR, 5:24838
Search for the production of a new quark flavor at the highest PETRA energies (33 to 35.8 GeV (c.m.)), 5:24835 (DOE/ER/03069—770)
ELECTRONS
See also SOLAR ELECTRONS
TRAPPED ELECTRONS
ELECTRONS/EXCHANGE INTERACTIONS
k dependence of the conduction-electron—local-moment exchange interaction in the atomic and covalent-mixing limits, 5:24402
ELECTRONS/MEAN FREE PATH
Electron mean free paths in solid organic insulators, 5:24724
ELECTROPHORESIS/LABORATORY EQUIPMENT
System for loading slab-gel holders for electrophoresis separation (DOE patent), 5:24492
ELECTROPHORESIS/STANDARDIZATION
Analytical techniques for cell fractions. XXVII. Use of heart proteins as reference standards in two-dimensional electrophoresis, 5:24673
ELECTROSTATIC PRECIPITATORS/BIBLIOGRAPHIES
Electrostatic precipitators. Volume 2. 1975-1977 (citations from the Engineering Index Data base). Report for 1975-77, 5:24544 (NTIS/PS—79/1035)
ELECTROSTATIC PRECIPITATORS/PERFORMANCE TESTING
EPA/IERL-RTP pilot electrostatic precipitator: selected experiments, 1978, 5:24031 (EPA—600/7-79-238)
ELMO BUMPY TORUS/ENERGY BALANCE
Ring power balance scaling: implications for a reactor, 5:25016 (ORNL/TM—7302)
EMBANKMENTS/BUILDING MATERIALS
Engineering approach for using power plant ash in a structural fill, 5:23497 (METC/SP—79/10(Pt.2))
Experience with geotechnical methods for design of flyash embankments and structural fills, 5:23498 (METC/SP—79/10(Pt.2))
EMBANKMENTS/DESIGN
Experience with geotechnical methods for design of flyash embankments and structural fills, 5:23498 (METC/SP—79/10(Pt.2))
EMERGENCY CORE COOLING SYSTEM
See ECCS
EMERGENCY PLANS/COST BENEFIT ANALYSIS
Analysis of Federal Government energy emergency programs. Energy policy study, Volume 5. AR/EI-80-05, 5:24195 (DOE/EIA—0201/5)
EMERGENCY PLANS/MANAGEMENT
Crisis intervention programs in Federal Region III: a policy perspective, 5:24180 (PB—300758)
EMERGENCY PLANS/PRICING REGULATIONS
Analysis of Federal Government energy emergency programs. Energy policy study, Volume 5. AR/EI-80-05, 5:24195 (DOE/EIA—0201/5)
ENCAPSULATION/EQUIPMENT
Method and means of packaging nuclear fuel rods for handling (Patent), 5:24076
END USE SECTOR
See COMMERCIAL SECTOR
INDUSTRY
ENERGY
See also GEOTHERMAL ENERGY
NUCLEAR ENERGY
SOLAR ENERGY
ENERGY/DATA BASE MANAGEMENT
Spatial data on energy, environmental, health, and socio-economic themes at Oak Ridge National Laboratory: 1979 inventory, 5:24175 (ORNL—5636)
ENERGY/EMPLOYMENT
Educational and demographic characteristics of energy-related scientists and engineers, 1976, 5:24332 (DOE/IR/0033—T2)
Energy-related scientists and engineers: a statistical profile of recent entrants into the work force, 1978, 5:24333 (DOE/OR/00033—T1)
ENERGY/MANPOWER
Educational and demographic characteristics of energy-related scientists and engineers, 1976, 5:24332 (DOE/IR/0033—T2)
Energy-related scientists and engineers: a statistical profile of recent entrants into the work force, 1978, 5:24333 (DOE/OR/00033—T1)
ENERGY BUDGETS/STANDARDS
Examination of implementation strategies for the Building Energy Performance Standards, 5:24255 (DOE/PE/70106—T1)
ENERGY CONSERVATION
Conservation and the changing direction of economic growth (Book; 6 papers), 5:24199
ENERGY CONSERVATION/EDUCATION
Federal energy conservation programs pursuant to section 381 of the Energy Policy and Conservation Act (Public Law 94-163). Annual report to Congress, 5:24190 (DOE/CS—0162)
ENERGY CONSERVATION/EMERGENCY PLANS
Analysis of Federal Government energy emergency programs. Energy policy study, Volume 5. AR/EI-80-05, 5:24195 (DOE/EIA—0201/5)
ENERGY CONSERVATION/EVALUATION
Evaluation of the State Energy Conservation Program from program initiation to September 1978. Final report, 5:24191 (DOE/CS/1697—01)
Project evaluation and quality control, 5:24262 (PB—301048)
ENERGY CONSERVATION/HEALTH HAZARDS
Impact of reduced infiltration and ventilation on indoor air quality, 5:24624
ENERGY CONSERVATION/INFORMATION NEEDS
Federal energy conservation programs pursuant to section 381 of the Energy Policy and Conservation Act (Public Law 94-163). Annual report to Congress, 5:24190 (DOE/CS—0162)
ENERGY CONSERVATION/QUALITY CONTROL
Project evaluation and quality control, 5:24262 (PB—301048)
ENERGY CONSERVATION/STANDARDS
Evaluation of the State Energy Conservation Program from program initiation to September 1978. Final report, 5:24191 (DOE/CS/1697—01)
ENERGY CONSERVATION/TECHNOLOGY ASSESSMENT
Residential energy conservation. Volume II. Working papers, 5:24257 (PB—301200)
ENERGY CONSUMPTION/DATA COMPILATION
Buildings energy use data book. Edition 2, 5:24244 (ORNL—5552)
ENERGY CONSUMPTION/ECONOMIC ELASTICITY
Energy demand and interfuel substitution in India (Use of translog price possibility frontier), 5:24198
ENERGY CONSUMPTION/FORECASTING
National energy problem in perspective (To year 2000), 5:24194 (CONF-7910153—1)
ENERGY CONSUMPTION/MANAGEMENT
Energy management in the Federal Government, 5:24174 (DOE/S—0005(79))
ENERGY CONSUMPTION/STATISTICS
Buildings energy use data book. Edition 2, 5:24244 (ORNL—5552)
ENERGY DEMAND
Energy demand and interfuel substitution in India (Use of translog price possibility frontier), 5:24198
ENERGY DEMAND/COMPARATIVE EVALUATIONS
International comparisons of the residential demand for energy, 5:24258
ENERGY DEMAND/ENERGY MODELS
International comparisons of the residential demand for energy, 5:24258
ENERGY DEMAND/ENERGY POLICY
Economic assessment of alternative energy policies, 5:24201 (BNL—27721)
ENERGY EFFICIENCY
Federal energy conservation programs pursuant to section 381 of the Energy Policy and Conservation Act (Public Law 94-163). Annual report to Congress, 5:24190 (DOE/CS—0162)
ENERGY EFFICIENCY/ECONOMIC IMPACT
Shifting MX expenditures to energy efficiency: memo on the national security implications of alternative energy development, 5:24192 (CEP-OP—0-2)

ENERGY EFFICIENCY/INVESTMENT
Shifting MX expenditures to energy efficiency: memo on the national security implications of alternative energy development, 5:24192 (CEP-OP—0-2)
ENERGY FACILITIES
See also RESOURCE RECOVERY FACILITIES
ENERGY FACILITIES/ENVIRONMENTAL IMPACTS
Applications of computer graphics to integrated environmental assessments of energy systems. Milestone report 1976-77, 5:24185 (PB—300358)
ENERGY MANAGEMENT
Conservation and the changing direction of economic growth (Book; 6 papers), 5:24199
ENERGY MODELS
Energy demand and interfuel substitution in India (Use of translog price possibility frontier), 5:24198
Energy-industry-environment system of Baden-Wuerttemberg, 5:24176 (IKE-K—54-19)
International comparisons of the residential demand for energy (Using indiret translog utility function), 5:24258
ENERGY POLICY
Conservation and the changing direction of economic growth (Book; 6 papers), 5:24199
Policy and Fiscal Guidance: energy projections. Appendix D, 5:24196 (DOE/PE—00/8)
ENERGY POLICY/BIBLIOGRAPHIES
Energy policy and research planning. Volume 3. October, 1977-September, 1979 (a bibliography with abstracts). Report for October 1977-September 1979, 5:24205 (NTIS/PS—79/1069)
ENERGY POLICY/ECONOMIC IMPACT
Economic assessment of alternative energy policies, 5:24201 (BNL—27721)
ENERGY POLICY/ENERGY ANALYSIS
Framework for energy policy and technology assessment in developing countries: a case study of Peru, 5:24200 (BNL—27613)
ENERGY POLICY/ENVIRONMENTAL IMPACTS
Economic assessment of alternative energy policies, 5:24201 (BNL—27721)
ENERGY POLICY/EVALUATION
On the Hill: energy muddlization, 5:24208
ENERGY POLICY/FINANCIAL INCENTIVES
Selected federal tax and non-tax subsidies for energy use and production. Energy policy study, Volume 6. AR/EA/80-01, 5:24202 (DOE/EIA—0201/6)
ENERGY POLICY/PLANNING
Energy policy and research planning. Volume 3. October, 1977-September, 1979 (a bibliography with abstracts). Report for October 1977-September 1979, 5:24205 (NTIS/PS—79/1069)
ENERGY POLICY/POLITICAL ASPECTS
Politics of energy, 5:24184
ENERGY POLICY/RECOMMENDATIONS
Where Carter's energy program goes wrong, 5:24207
ENERGY POLICY/SUBSIDIES
Selected federal tax and non-tax subsidies for energy use and production. Energy policy study, Volume 6. AR/EA/80-01, 5:24202 (DOE/EIA—0201/6)
ENERGY POLICY/TAXES
Selected federal tax and non-tax subsidies for energy use and production. Energy policy study, Volume 6. AR/EA/80-01, 5:24202 (DOE/EIA—0201/6)
ENERGY POLICY AND CONSERVATION ACT/IMPLEMENTATION
Evaluation of the State Energy Conservation Program from program initiation to September 1978. Final report, 5:24191 (DOE/CS/1697—01)
Federal energy conservation programs pursuant to section 381 of the Energy Policy and Conservation Act (Public Law 94-163). Annual report to Congress, 5:24190 (DOE/CS—0162)
ENERGY SHORTAGES/ECONOMIC IMPACT
Coping with energy limitations in transportation: proposals for Michigan, 5:24179 (PB—299737)
ENERGY SHORTAGES/EMERGENCY PLANS
Crisis intervention programs in Federal Region III: a policy perspective, 5:24180 (PB—300758)
ENERGY SOURCE DEVELOPMENT
Energy from the west: energy resource development systems report. Volume III: oil shale. Final report, 1975-1978, 5:23668 (PB—299179)
ENERGY SOURCE DEVELOPMENT/ECONOMIC IMPACT
Proceedings of the third workshop on the energy development board of Mercer County, North Dakota, 5:24177 (CONF-791178—)
ENERGY SOURCE DEVELOPMENT/EVALUATION
Framework for energy policy and technology assessment in developing countries: a case study of Peru, 5:24200 (BNL—27613)
ENERGY SOURCE DEVELOPMENT/FINANCIAL INCENTIVES
Analysis of federal incentives used to stimulate energy production: an executive summary, 5:24182 (PNL—2410(Rev.2))
ENERGY SOURCE DEVELOPMENT/INVESTMENT
Shifting MX expenditures to energy efficiency: memo on the national security implications of alternative energy development, 5:24192 (CEP-OP—0-2)
ENERGY SOURCE DEVELOPMENT/MANAGEMENT
Proceedings of the third workshop on the energy development board of Mercer County, North Dakota, 5:24177 (CONF-791178—)
ENERGY SOURCE DEVELOPMENT/PLANNING
Jobs and power for Alaskans - a program for power and economic development, 5:24178 (PB—299729)
ENERGY SOURCE DEVELOPMENT/POLITICAL ASPECTS
Politics of energy, 5:24184
ENERGY SOURCE DEVELOPMENT/SOCIAL IMPACT
Proceedings of the third workshop on the energy development board of Mercer County, North Dakota, 5:24177 (CONF-791178—)
ENERGY SOURCES
See also FOSSIL FUELS
WAVE POWER
WIND POWER
ENERGY SOURCES/COMPARATIVE EVALUATIONS
Alternative power sources for air force terrestrial requirements, 5:24247
Western coal project, 5:23567
ENERGY SOURCES/GLOBAL ASPECTS
Global perspective on energy (Projecting into 21st century), 5:24193 (CONF-800403—43)
ENERGY STORAGE
See also FLYWHEEL ENERGY STORAGE
HEAT STORAGE
MAGNETIC ENERGY STORAGE
OFF-PEAK ENERGY STORAGE
Computer based electrical analysis of homopolar generator driven, bitter plate storage inductors with radial current diffusion, 5:25058
Rebuilding the five megajoule homopolar machine at the university of texas, 5:25057
ENERGY STORAGE SYSTEMS/COMPARATIVE EVALUATIONS
Comparison of alternate power sources for the MX missile system, 5:24334
ENERGY STORAGE SYSTEMS/REGENERATIVE FUEL CELLS
Fuel cells for electric utility and transportation applications, 5:24234 (BNL—27452)
ENERGY SUPPLIES/ENERGY POLICY
Economic assessment of alternative energy policies, 5:24201 (BNL—27721)
ENERGY SUPPLIES/FORECASTING
National energy problem in perspective (To year 2000), 5:24194 (CONF-7910153—1)
Policy and Fiscal Guidance: energy projections. Appendix D, 5:24196 (DOE/PE—00/8)
ENERGY SUPPLIES/GLOBAL ASPECTS
Global perspective on energy (Projecting into 21st century), 5:24193 (CONF-800403—43)
ENERGY-LEVEL TRANSITIONS/P INVARIANCE
What can we learn about nuclear electric dipole moments from parity nonconservation in atomic transitions?, 5:24864
ENGINEERS/CERTIFICATION
Quest for certified slar energy engineering personnel, 5:23801
ENGLAND
See UNITED KINGDOM
ENHANCED RECOVERY
See also CARBON DIOXIDE INJECTION
ENHANCED RECOVERY/RESEARCH PROGRAMS
Contracts for field projects and supporting research on enhanced oil recovery and improved drilling technology. Progress review No. 21, quarter ending December 31, 1979, 5:23576 (DOE/BETC—80/1)
ENTRAINMENT/BIOLOGICAL EFFECTS
Entrainment, 5:24761
ENTRAINMENT/ENVIRONMENTAL IMPACTS
Best approach to impact assessment is to use empirically based or simulation models to forecast impacts. Environmental Sciences Division Publication No. 1538 (Concerning the impact at power plants on fish populations), 5:24024 (CONF-800543—2)
Population-level assessments should be emphasized over community/ecosystem-level assessments. Environmental Sciences Division Publication No. 1535, 5:24025 (CONF-800543—3)

ENVIRONMENT/DATA BASE MANAGEMENT
Spatial data on energy, environmental, health, and socio-economic themes at Oak Ridge National Laboratory: 1979 inventory, 5:24175 (ORNL—5636)
ENVIRONMENTAL IMPACT STATEMENTS/EVALUATION
The Environmental Protection Agency and the Kaiparowits Power Project: a case study of EPA's performance of its environmental review responsibilities, 5:24028 (PB—300391)
ENVIRONMENTAL IMPACTS/COMPUTER GRAPHICS
Applications of computer graphics to integrated environmental assessments of energy systems. Milestone report 1976-77, 5:24185 (PB—300358)
ENVIRONMENTAL TRANSPORT
See also RADIONUCLIDE MIGRATION
RUNOFF
ENVIRONMENTAL TRANSPORT/MATHEMATICAL MODELS
User's manual for DWNWND: an interactive Gaussian plume atmospheric transport model with eight dispersion parameter options, 5:24633 (ORNL/TM—6874)
ENZYME ACTIVITY/RADIOSENSITIVITY
Does oxygen enhance the radiation: induced inactivation of penicillinase. Progress report, December 1, 1979-November 30, 1980, 5:24734 (DOE/EV/03221—62)
ENZYME INHIBITORS/BIOCHEMICAL REACTION KINETICS
Protonmotive cyclic electron flow around photosystem I in intact chloroplasts, 5:24686
EOR
See ENHANCED RECOVERY
EPCA
See ENERGY POLICY AND CONSERVATION ACT
EPIPHYSIS (BONES)
See BONE TISSUES
EPITHELIUM/CYTOLOGY
In vitro properties of epithelial cell lines established from human carcinomas and nonmalignant tissue, 5:24705
EPOXIDES/CURING
Synthesis of thermosetting polymers from the by-products of coal conversion processes, 5:23450
EPOXY COMPOUNDS
See EPOXIDES
EQUATIONS
See also DIFFERENTIAL EQUATIONS
EQUATIONS/NUMERICAL SOLUTION
Odd-even reduction for banded linear equations, 5:25114
EQUATIONS (DIFFERENTIAL)
See DIFFERENTIAL EQUATIONS
EQUILIBRIUM PLASMA/VARIATIONAL METHODS
Energy principle with global invariants, 5:25017 (PPPL—1659)
EQUIPMENT
See also CAPACITIVE ENERGY STORAGE EQUIPMENT
HEAT RECOVERY EQUIPMENT
MINING EQUIPMENT
POLLUTION CONTROL EQUIPMENT
THERMAL ENERGY STORAGE EQUIPMENT
WELL LOGGING EQUIPMENT
EQUIPMENT/PERFORMANCE TESTING
Coal liquefaction test center. Annual report, January 1, 1978-December 31, 1978, 5:23440 (FE—1517-89)
ERBIUM/SORPTIVE PROPERTIES
Gettering of carbon dioxide by erbium thin films, 5:24495 (GEPP-OP—482)
ERBIUM 164/HIGH SPIN STATES
High-spin properties of ^{164}Er in the multiple band crossing region, 5:24922
ERBIUM 165/ELECTRON CAPTURE DECAY
L/sub 2,3/-subshell x-ray fluorescence and Coster-Kronig yields at Z=64 and 67, 5:24815
ERBIUM 168/ROTATION
Flow patterns for collective rotations in heavy nuclei, 5:24920
EROSION/MONITORING
Materials technology for coal-conversion processes. Nineteenth report, July-December 1979, 5:23417 (ANL—80-12)
EROSION/SIMULATION
Effects of contour coal strip mining on stormwater runoff and quality, 5:23518 (ORO—4946-T1)
ERYTHROBLASTS
See BONE MARROW CELLS
ERYTHROCYTES/CYTOCHEMISTRY
Purification of two spectrin-binding proteins: biochemical and electron microscopic evidence for site-specific reassociation between spectrin and bands 2.1 and 4.1, 5:24704
ERYTHROCYTES/RADIOSENSITIVITY EFFECTS
Evidence for a change in the fluidity of erythrocyte membranes following x irradiation by measurement of pyrene excimer fluorescence, 5:24738
ERYTHROPOIETIN/BIOCHEMICAL REACTION KINETICS
Modulation of erythropoietin concentrations by manipulation of hypercarbia, 5:24690
ESTROGENS/RADIOSENSITIVITY EFFECTS
Synergism of diethylstilbestrol and radiation in mammary carcinogenesis in female F344 rats, 5:24749
ESTUARINE ECOSYSTEMS
See AQUATIC ECOSYSTEMS
1,2-ETHANEDIOL
See GLYCOLS
ETHANOL/BIOLOGICAL EFFECTS
Effects of ethanol on alanine metabolism in perfused mouse liver studied by ^{13}C NMR, 5:24717
ETHANOL/BIOSYNTHESIS
Agricultural sector impacts of making ethanol from grain, 5:23776 (SERI/TR—352-554)
Preliminary energy balance and economic of a farm-scale ethanol plant, 5:23775 (DOE/CS/4042—T36)
ETHANOL/FERMENTATION
Environmental implications of accelerated gasohol production: preliminary assessment, 5:23832 (ANL/ES—91)
ETHYLENE/SYNTHESIS
Conversion of coal-based methanol to ethylene and a gaseous fuel. Final report 1 October 1975-30 September 1978, 5:23773 (PB—301256)
ETHYLENE GLYCOL
See GLYCOLS
ETHYLENE POLYMERS
See POLYETHYLENES
EUPHORBIA/ENERGY SOURCES
Green factories, 5:23843
EUROPIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
EUROPIUM 155/BETA-MINUS DECAY
L/sub 2,3/-subshell x-ray fluorescence and Coster-Kronig yields at Z=64 and 67, 5:24815
EVACUATED TUBE COLLECTORS/DRAIN-DOWN SYSTEMS
Draining of the SUNPAK/sup TM/ evacuated tubular collector, 5:23949 (ALO—4150-12)
EVACUATED TUBE COLLECTORS/FIELD TESTS
Evacuated tubular collector utilizing a heat pipe. Final report, August 1-September 30, 1977, 5:23950 (COO—2608-3)
EVACUATED TUBE COLLECTORS/MODIFICATIONS
Draining of the SUNPAK/sup TM/ evacuated tubular collector, 5:23949 (ALO—4150-12)
EVACUATED TUBE COLLECTORS/RESEARCH PROGRAMS
Active solar collector and materials research, 5:23952 (LA-UR—80-852)
EVACUATED TUBE COLLECTORS/THERMAL ANALYSIS
Evacuated tubular collector utilizing a heat pipe. Final report, August 1-September 30, 1977, 5:23950 (COO—2608-3)
EVEN-EVEN NUCLEI/YRAST STATES
Pseudomagic nuclei, 5:24940
EXCHANGE INTERACTIONS/PRIMAKOFF EFFECT
K/sub S/^{0*} and its uses, 5:24860
EXCITONS/BIOCHEMICAL REACTION KINETICS
Picosecond fluorescence studies of exciton migration and annihilation in photosynthetic systems. A review, 5:24693
EXCITONS/PHOTOSYNTHESIS
Picosecond fluorescence studies of exciton migration and annihilation in photosynthetic systems. A review, 5:24693
EXHAUST GASES/AIR POLLUTION
Transortation Control Plan. Volume 3: Technical Documentation (Plan for control of traffic-related air pollution in Baltimore metropolitan area through 1987), 5:24599 (PB—297525)
EXHAUST GASES/BIBLIOGRAPHIES
Nitrogen oxide air pollution. Part 2. Detection and analysis. Volume2. 1976-August, 1979 (a bibliography with abstracts). Report for 1976-August 1979, 5:24595 (NTIS/PS—79/1058)
EXHAUST GASES/GAS ANALYSIS
Nitrogen oxide air pollution. Part 2. Detection and analysis. Volume2. 1976-August, 1979 (a bibliography with abstracts). Report for 1976-August 1979, 5:24595 (NTIS/PS—79/1058)
EXHAUST GASES/MONITORING
Diesel hydrocarbon measurement - series filter test. Technical report, 5:24356 (PB—301410)
EXOELECTRON DOSEMETERS/PERFORMANCE
Ceramic BeO exoelectron dosimeters for tritium and radon monitoring, 5:24561 (CONF-7910149—1)
EXPERIMENTAL BREEDER REACTOR-2
See EBR-2 REACTOR

EXTERNAL IRRADIATION/DOSE COMMITMENTS
PABLM: a computer program to calculate accumulated radiation doses from radionuclides in the environment, 5:24754 (PNL—3209)

F

F-2030 RESONANCES/DECAY
Flavor mixing and charm decay, 5:24861 (BNL—27615)
FAILED ELEMENT DETECTION/ACCURACY
Development of a methodology for analysis of delayed-neutron signals (LMFBR), 5:24051 (ANL—79-57)
FARADAY GENERATORS
See MHD GENERATORS
FARMS/RESOURCE CONSERVATION
Resource-conserving agricultural production methods. Progress report August 1977-July 1978, 5:24301 (PB—301042)
FARMS/WASTE PRODUCT UTILIZATION
Resource-conserving agricultural production methods. Progress report August 1977-July 1978, 5:24301 (PB—301042)
FAST FLUX TEST FACILITY REACTOR
See FFTF REACTOR
FATTY ACIDS
See CARBOXYLIC ACIDS
FEDAL
See FAILED ELEMENT DETECTION
FEDERAL BUILDINGS/ENERGY CONSERVATION
Energy management in the Federal Government, 5:24174 (DOE/S—0005(79))
Federal energy conservation programs pursuant to section 381 of the Energy Policy and Conservation Act (Public Law 94-163). Annual report to Congress, 5:24190 (DOE/CS—0162)
FEDERAL BUILDINGS/ENERGY CONSUMPTION
Energy management in the Federal Government, 5:24174 (DOE/S—0005(79))
FEDERAL GOVERNMENT
See NATIONAL GOVERNMENT
FEDERAL REPUBLIC OF GERMANY/ENERGY POLICY
Alternative scenario for energy policy: analysis, questions, and remarks on Dr. Erhard Eppler's alternative scenario for energy policy, 5:24204 (Juel-Spez—55)
FEDERAL REPUBLIC OF GERMANY/SOLAR ENERGY
Solar energy in Europe, 5:23796
FEED MATERIALS PLANTS/ECONOMICS
Commercial development considerations, 5:23712
FEED MATERIALS PLANTS/REVIEWS
Uranium milling, 5:23701
FEED MATERIALS PLANTS/WATER REQUIREMENTS
State policies and requirements for management of uranium mining and milling in New Mexico. Volume II. Water availability in the San Juan Structural Basin, 5:23754 (SAND—78-1331)
FEMALES/DELAYED RADIATION EFFECTS
Long-term effects of radium exposure in female dial workers: liver function and liver disease, 5:24778
FERMIONS
See also LEPTONS
FERMIONS/REGGE TRAJECTORIES
Reggeization of elementary fermions in arbitrary renormalizable gauge theories, 5:24858
FERMIUM 258/SPONTANEOUS FISSION
Fission properties of the heavy actinides, 5:24938
FERMIUM 259/SPONTANEOUS FISSION
Fission properties of the heavy actinides, 5:24938
FERNS/BIOLOGICAL INDICATORS
Plant developmental system to measure the impact of pollutants in rain water, 5:24768
FERRATES
See IRON OXIDES
FERRITES/MICROSTRUCTURE
Comparative analysis of the cellular and Johnson-Mehl microstructures through computer simulation, 5:24376
FERROELECTRIC CONVERTERS/DESIGN
Pyroelectric apparatus including effectively intrinsic semiconductor for converting radiant energy into electric energy (Patent), 5:23802
FERTILITY/BIOLOGICAL INDICATORS
Plant developmental system to measure the impact of pollutants in rain water, 5:24768
FERTILITY/PATHOLOGICAL CHANGES
Plant developmental system to measure the impact of pollutants in rain water, 5:24768
FERTILIZERS/CHEMICAL FEEDSTOCKS
Status of the fertilizer industry in India, 5:23789
FERTILIZERS/PRODUCTION
Changing patterns in world nitrogen fertilizer production and trade, 5:24209 (UCID—18621)
Coal-based ammonia plants: preliminary operating experience of coal gasification at Talcher and Ramagundam fertilizer plants of The Fertilizer Corporation of India, 5:23788
Status of the fertilizer industry in India, 5:23789
FERTILIZERS/RAW MATERIALS
Potential importance of coal as a feedstock for the US fertilizer industry in the future, 5:23780
FERTILIZERS/RESEARCH PROGRAMS
TVA-NFDC role in fertilizer development, 5:23779
FETUSES/MORTALITY
Analysis of the albino-locus region of the mouse. III. Time of death of prenatal lethals, 5:24750
FETUSES/RADIONUCLIDE KINETICS
Cross-placental transfer of ^{243} ^{4}Cm in the baboon, 5:24759 (COO—3382-18)
FFTF REACTOR/MELTDOWN
Containment response to postulated core meltdown accidents in the fast flux test facility, 5:24098
FFTF REACTOR/RHR SYSTEMS
Containment response to postulated core meltdown accidents in the fast flux test facility, 5:24098
FIBROBLASTS/BIOLOGICAL RADIATION EFFECTS
Oncogenic transformation of mammalian cells in vitro with split doses of x rays, 5:24740
FIBROBLASTS/CARCINOGENESIS
Is the product of the src gene a promoter, 5:24714
FIBROBLASTS/RADIOSENSITIVITY
Repair of ultraviolet light damage to the DNA of cultured human epidermal keratinocytes and fibroblasts, 5:24742
FIELD EMISSION/CURRENT DENSITY
Obtaining numerical values for the elliptic emission functions used in calculating electron emission from surfaces, 5:24957
FIELD EMISSION MICROSCOPY
See ION MICROSCOPY
FIELD ION MICROSCOPY
See ION MICROSCOPY
FIELD THEORIES/RENORMALIZATION
1/N expansion and the theory of composite particles, 5:24882
FIELD-REVERSED MIRROR REACTORS/ION SOURCES
Intense pulsed ion beams for fusion applications, 5:25075 (SAND—80-0402)
FILLING STATIONS
See GASOLINE SERVICE STATIONS
FILMS
(Not for PHOTOGRAPHIC FILMS or NUCLEAR EMULSIONS.)
FILMS/FABRICATION
Preparation of thin films for solar energy utilization, 5:23825
FINANCIAL ASSISTANCE/PROFESSIONAL PERSONNEL
Department of Energy Procurement and Financial-Assistance Career Guide, 5:24173 (DOE/PR—0038)
FINITE ELEMENT METHOD
High-order curved finite elements (Construction of basis functions), 5:25110 (KAPL—4134)
FINITE ELEMENT METHOD/ACCURACY
A-posteriori error estimates for the finite element method, 5:25115
FIREDAMP
See METHANE
FISH CULTURE
See AQUACULTURE
FISHES/MORTALITY
Impact of impingement on the Hudson River white perch population, 5:24026 (CONF-800543—4)
FISHES/SURVIVAL TIME
Marine fisheries review, volume 41, number 3, March 1979, 5:24656 (PB—300280)
FISHES/TEMPERATURE EFFECTS
Effect of tetracycline hydrochloride treatment on the critical thermal maximum of common shiners, 5:24773
FISHES/TOXICITY
Potential toxic effects on aquatic biota from oil shale development, 5:23666
FISSION PRODUCTS/MASS SPECTRA
Fission properties of the heavy actinides, 5:24938
FISSURED FORMATIONS
See FRACTURED RESERVOIRS
FLASKS
See CASKS
FLAT PLATE COLLECTORS
See also TRICKLE-TYPE COLLECTORS
FLAT PLATE COLLECTORS/DESIGN
Development of a site-fabricated building integrated air collector. Third quarterly report, March 31-June 30, 1978, 5:23946 (ALO—4123-T1)
Open backflow system, 5:23970

Solar heat roofing system (Patent), 5:23963
Solar panel (Patent), 5:23968
FLAT PLATE COLLECTORS/HEAT LOSSES
Natural convection heat transfer in small and moderate aspect ratio enclosures: an application to flat plate collectors, 5:23973
FLAT PLATE COLLECTORS/NATURAL CONVECTION
Natural convection heat transfer in small and moderate aspect ratio enclosures: an application to flat plate collectors, 5:23973
FLAT PLATE COLLECTORS/PERFORMANCE
Development of a site-fabricated building integrated air collector. Third quarterly report, March 31-June 30, 1978, 5:23946 (ALO—4123-T1)
FLAVOR MODEL/CONFIGURATION MIXING
Flavor mixing and charm decay, 5:24861 (BNL—27615)
FLORIDA/ELECTRIC UTILITIES
Analysis of environmental factors affecting technology deployment: a case study, 5:24027 (DOE/RA/10001—T1)
FLOW (FLUID)
See FLUID FLOW
FLOWMETERS/PERFORMANCE TESTING
Development of impedance sensors at ORNL: for measurement of two-phase flows (PWR), 5:24085 (CONF-791118—10)
FLUCTUATIONS/QUANTUM MECHANICS
Quantum-mechanical fluctuations of the resonance-radiation force, 5:24883
FLUE GAS/CLEANING
EPA/IERL-RTP pilot electrostatic precipitator: selected experiments, 1978, 5:24031 (EPA—600/7-79-238)
FLUE GAS/DECARBONIZATION
Options for the collection and disposal of carbon dioxide, 5:24036 (ORNL—5657)
FLUE GAS/DESULFURIZATION
Characterization of flue gas cleaning (FGC) wastes from coal combustion, 5:23480 (METC/SP—79/10(Pt.1))
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 1. Task I report: literature review, basis for selecting calcium-based sorbents. Final report, 5:24032 (EPRI-FP—1307(Vol.1))
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 2. Tasks II and III report: experimental work, sorbent selection technique. Final report, November 1, 1976-July 31, 1977, 5:24033 (EPRI-FP—1307(Vol.2))
FLUE GAS/HOT GAS CLEANUP
Glass-fly ash from a new hot gas clean-up process, 5:23413 (METC/SP—79/10(Pt.1))
FLUID FLOW
See also LAMINAR FLOW
TWO-PHASE FLOW
FLUID FLOW/HYDRODYNAMIC MODEL
Thermodynanmic relations between selected parameters describing unsaturated flow, 5:24780 (DOE/DP/01253—18)
FLUID MECHANICS/INCOMPRESSIBLE FLOW
Numerical methods for a general class of porous medium equations, 5:24974 (ANL—80-39)
FLUID WITHDRAWAL/ENVIRONMENTAL IMPACTS
Geothermal environmental impact assessment: subsurface environmental assessment for four geothermal systems, 5:23994 (PB—300851)
FLUIDIZED BED/CHEMICAL VAPOR DEPOSITION
Coated woven materials and method of preparation (Patent), 5:24453
FLUIDIZED BED/CONVECTION
Convective instability of a volumetrically heated porous bed, 5:23978
FLUIDIZED BED/MATHEMATICAL MODELS
Convective instability of a volumetrically heated porous bed, 5:23978
FLUIDIZED-BED COMBUSTION/DEMONSTRATION PLANTS
Design, construction, operation and evaluation of a prototype culm combustion boiler/heater unit: site evaluation and socio-economic impact, 5:23459 (FE—3269-11A)
FLUIDIZED-BED COMBUSTION/EVALUATION
Fluidized-bed combustion process evaluation and program support. Quarterly report, October-December 1979, 5:23558 (ANL/CEN/FE—80-1)
FLUIDIZED-BED COMBUSTION/RESEARCH PROGRAMS
Fluidized-bed combustion process evaluation and program support. Quarterly report, October-December 1979, 5:23558 (ANL/CEN/FE—80-1)
FLUIDIZED-BED COMBUSTION/TEST FACILITIES
Measuring and modeling solids movement in a large, cold fluidized bed test facility. First quarterly report, 1 October, 31 December 1979 (More than 100 references), 5:23560 (DOE/ET/13152—1)
FLUIDIZED-BED COMBUSTORS/ABRASION
Attrition and elutriation phenomena in industrial atmospheric fluidized bed combustors, 5:23559 (CONF-800545—1)
FLUIDIZED-BED COMBUSTORS/AIR POLLUTION CONTROL
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 1. Task I report: literature review, basis for selecting calcium-based sorbents. Final report, 5:24032 (EPRI-FP—1307(Vol.1))
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 2. Tasks II and III report: experimental work, sorbent selection technique. Final report, November 1, 1976-July 31, 1977, 5:24033 (EPRI-FP—1307(Vol.2))
FLUIDIZED-BED COMBUSTORS/DESIGN
Engineer, design, construct, test and evaluate a pressurized fluidized bed pilot plant using high sulfur coal for production of electric power, 5:23561 (FE—1726-34A)
FLUIDIZED-BED COMBUSTORS/ELUTRIATION
Attrition and elutriation phenomena in industrial atmospheric fluidized bed combustors, 5:23559 (CONF-800545—1)
FLUIDIZED-BED COMBUSTORS/FAILURE MODE ANALYSIS
Reliability analysis of the Georgetown University Atmospheric Fluidized Bed Combustor. Final report, 5:24543 (SAI—129-79-PGH)
FLUIDIZED-BED COMBUSTORS/FLUE GAS
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 1. Task I report: literature review, basis for selecting calcium-based sorbents. Final report, 5:24032 (EPRI-FP—1307(Vol.1))
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 2. Tasks II and III report: experimental work, sorbent selection technique. Final report, November 1, 1976-July 31, 1977, 5:24033 (EPRI-FP—1307(Vol.2))
FLUIDIZED-BED COMBUSTORS/HEAT TRANSFER
Engineer, design, construct, test and evaluate a pressurized fluidized bed pilot plant using high sulfur coal for production of electric power, 5:23561 (FE—1726-34A)
FLUIDS
See also GASES
GEOTHERMAL FLUIDS
LIQUIDS
WORKING FLUIDS
FLUIDS/DIFFUSION
Numerical methods for a general class of porous medium equations, 5:24974 (ANL—80-39)
FLUIDS/STRUCTURE FACTORS
Bulk viscosity via nonequilibrium and equilibrium molecular dynamics, 5:24833
FLUIDS/VISCOSITY
Bulk viscosity via nonequilibrium and equilibrium molecular dynamics, 5:24833
FLUORESCENT CONCENTRATORS
See LUMINESCENT CONCENTRATORS
FLUORINATED ALIPHATIC HYDROCARBONS
See also FLUOROFORM
FLUORINATED ALIPHATIC HYDROCARBONS/PHOTOCHEMICAL REACTIONS
Deuterium separation at high pressure by nanosecond CO_2 laser multiple-photon dissociation, 5:24497
FLUORINE/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
FLUORINE 19 TARGET/HELIUM 3 REACTIONS
Description of direct nuclear rearrangement reactions using various coupled channel equations, 5:24946
FLUOROFORM/PHOTOCHEMICAL REACTIONS
Deuterium separation at high pressure by nanosecond CO_2 laser multiple-photon dissociation, 5:24497
FLUTE INSTABILITY
Growth rates of interchange modes in the dense z-pinch and gas blanket effects, 5:25024 (LA—8340-MS)
FLY ASH/CHEMICAL COMPOSITION
Australian cenospheres, 5:23469 (METC/SP—79/10(Pt.1))
Cement as admixture to fly ash concrete (Conformite products added to mixture), 5:24311 (METC/SP—79/10(Pt.2))
Characterization of flue gas cleaning (FGC) wastes from coal combustion, 5:23480 (METC/SP—79/10(Pt.1))
Fly ash in paving and structural concrete, 5:23489 (METC/SP—79/10(Pt.2))
Laboratory study of the effects of SO_3 and autoclave expansion of fly ash on concrete expansion and compressive strength, 5:23485 (METC/SP—79/10(Pt.2))
Mechanical strength development and permeability of fly ash-sludge-lime mixtures, 5:23475 (METC/SP—79/10(Pt.1))

New developments in the lime-soda sinter process for recovery of alumina from fly ash, 5:23466 (METC/SP—79/10(Pt.1))
Recovery of resource materials from coal ash, 5:23470 (METC/SP—79/10(Pt.1))
Research and utilization of Indian fly ashes in cement manufacture: an overview, 5:23492 (METC/SP—79/10(Pt.2))
Role of fly ash in structural types of stabilized applications, 5:23478 (METC/SP—79/10(Pt.1))
Sources of pozzolanic activities in fly ashes: a critical review, 5:23490 (METC/SP—79/10(Pt.2))
Use of the magnetic fraction of fly ash as a heavy medium material in coal washing, 5:23542 (METC/SP—79/10(Pt.1))

FLY ASH/CHEMICAL PROPERTIES
Role of fly ash in structural types of stabilized applications, 5:23478 (METC/SP—79/10(Pt.1))
Sources of pozzolanic activities in fly ashes: a critical review, 5:23490 (METC/SP—79/10(Pt.2))

FLY ASH/DENSITY
Australian cenospheres, 5:23469 (METC/SP—79/10(Pt.1))

FLY ASH/EVALUATION
Criterion of estimating the efficiency of fly-ashes in cements and concretes, 5:23491 (METC/SP—79/10(Pt.2))
Research and utilization of Indian fly ashes in cement manufacture: an overview, 5:23492 (METC/SP—79/10(Pt.2))

FLY ASH/HYDRATION
Hydration development of fly ash cements as measured by the NMR, 5:24462 (METC/SP—79/10(Pt.2))

FLY ASH/IMPURITIES
Responsibility for quality control and quality assurance of fly ash, 5:23462 (METC/SP—79/10(Pt.1))

FLY ASH/LEACHING
Environmentally acceptable disposal of coal conversion solid waste residuals. Progress report, April 21, 1979-July 31, 1979, 5:23458 (DOE/PC/20023—1)
Estimating the leaching potential of coal combustion by-products, 5:23483 (METC/SP—79/10(Pt.2))

FLY ASH/MAGNETIC SEPARATORS
Use of the magnetic fraction of fly ash as a heavy medium material in coal washing, 5:23542 (METC/SP—79/10(Pt.1))

FLY ASH/MARKET
Economic and environmental aspects of a new coal ash recycling/disposal process, 5:23481 (METC/SP—79/10(Pt.1))
Fly ash for use in the industrial extender market, 5:23468 (METC/SP—79/10(Pt.1))
Responsibility for quality control and quality assurance of fly ash, 5:23462 (METC/SP—79/10(Pt.1))

FLY ASH/MATERIALS RECOVERY
Engineering analysis and comparison of new processes for the recovery of resource materials from coal ash (Lime-soda, salt-soda, nitric acid, Calsinter and Bayer processes), 5:23465 (METC/SP—79/10(Pt.1))
Recovery of resource materials from coal ash, 5:23470 (METC/SP—79/10(Pt.1))

FLY ASH/NATURAL RADIOACTIVITY
Determination of ^{226}Ra, ^{214}Pb, and ^{214}Bi in fly ash samples from eighteen (18) coal fired power plants in the United States, 5:23457 (METC/SP—79/10(Pt.1))

FLY ASH/NUCLEAR MAGNETIC RESONANCE
Hydration development of fly ash cements as measured by the NMR, 5:24462 (METC/SP—79/10(Pt.2))

FLY ASH/PHYSICAL PROPERTIES
Characterization of flue gas cleaning (FGC) wastes from coal combustion, 5:23480 (METC/SP—79/10(Pt.1))
Fly ash for use in the industrial extender market, 5:23468 (METC/SP—79/10(Pt.1))
Role of fly ash in structural types of stabilized applications, 5:23478 (METC/SP—79/10(Pt.1))
Sources of pozzolanic activities in fly ashes: a critical review, 5:23490 (METC/SP—79/10(Pt.2))

FLY ASH/PRODUCTION
Engineering approach for using power plant ash in a structural fill, 5:23497 (METC/SP—79/10(Pt.2))
New Trief cement process: what has become of Trief cement and portland industry since 1976 (Arguments in favor of new manufacturing process), 5:23493 (METC/SP—79/10(Pt.2))

FLY ASH/QUALITY CONTROL
Research and utilization of Indian fly ashes in cement manufacture: an overview, 5:23492 (METC/SP—79/10(Pt.2))
Responsibility for quality control and quality assurance of fly ash, 5:23462 (METC/SP—79/10(Pt.1))

FLY ASH/REVEGETATION
Revegetation study of eastern and western fly ash, 5:23507 (METC/SP—79/10(Pt.2))

FLY ASH/SAMPLING
Research and utilization of Indian fly ashes in cement manufacture: an overview, 5:23492 (METC/SP—79/10(Pt.2))

FLY ASH/SEDIMENTATION
Field retention time studies of ash settling ponds, 5:23474 (METC/SP—79/10(Pt.1))

FLY ASH/SEPARATION PROCESSES
Fly ash for use in the industrial extender market, 5:23468 (METC/SP—79/10(Pt.1))

FLY ASH/SPECIFICATIONS
Research and utilization of Indian fly ashes in cement manufacture: an overview, 5:23492 (METC/SP—79/10(Pt.2))
Responsibility for quality control and quality assurance of fly ash, 5:23462 (METC/SP—79/10(Pt.1))
Specifications on fly ash for use in concrete: where we are - where should we go, 5:23484 (METC/SP—79/10(Pt.2))
Standard specification for fly ash and raw or calcined natural pozzolan for use as a mineral admixture in portland cement concrete (ASTM C 618-78), 5:23511 (METC/SP—79/10(Pt.2))

FLY ASH/STABILIZATION
By-product-utilization/ultimate-disposal of gas cleaning wastes from coal-fired power generation, 5:23477 (METC/SP—79/10(Pt.1))
Delayed compaction of high calcium fly ash stabilized soil, 5:23499 (METC/SP—79/10(Pt.2))
Largest use of fly ash-scrubber sludge disposal, 5:23476 (METC/SP—79/10(Pt.1))

FLY ASH/WARRANTIES
Title 15, United States Code, Section 2300: consumer product warranties. The Magnuson-Moss Warranty Act (Limitation for protection of vendor), 5:24314 (METC/SP—79/10(Pt.2))
Uniform Commercial Code (UCC), sections from Article 2: sales (Vendor protection), 5:23512 (METC/SP—79/10(Pt.2))

FLY ASH/WASTE DISPOSAL
Economic and environmental aspects of a new coal ash recycling/disposal process, 5:23481 (METC/SP—79/10(Pt.1))
Effects of seepage from fly-ash settling ponds and construction dewatering on ground-water levels in the Cowles Unit, Indiana Dunes National Lakeshore, Indiana. Water-resources investigations (final) 1976-77, 5:24660 (PB—300843)
Evaluation of ash storage sites: a case history, 5:23479 (METC/SP—79/10(Pt.1))
Fly ash ponds, 5:23473 (METC/SP—79/10(Pt.1))
Largest use of fly ash-scrubber sludge disposal, 5:23476 (METC/SP—79/10(Pt.1))
Revegetation study of eastern and western fly ash, 5:23507 (METC/SP—79/10(Pt.2))
Some effects of western coal fly ash on municipal sewage sludge, 5:24313 (METC/SP—79/10(Pt.2))

FLY ASH/WASTE PRODUCT UTILIZATION
Accelerated sulfate testing of mortars containing fly ash as a partial replacement for portland cement, 5:23487 (METC/SP—79/10(Pt.2))
Advances in marketing Pozzolanic road bases, 5:23503 (METC/SP—79/10(Pt.2))
Application of fly ash and other wastes to mine soils as an aid in revegetation, 5:23517 (METC/SP—79/10(Pt.2))
Ash liability in cement replacement, 5:23488 (METC/SP—79/10(Pt.2))
Ash utilization in bikeway construction, 5:23496 (METC/SP—79/10(Pt.2))
Australian cenospheres, 5:23469 (METC/SP—79/10(Pt.1))
Characteristics of Australian flyash concrete, 5:23486 (METC/SP—79/10(Pt.2))
Criterion of estimating the efficiency of fly-ashes in cements and concretes, 5:23491 (METC/SP—79/10(Pt.2))
Delayed compaction of high calcium fly ash stabilized soil, 5:23499 (METC/SP—79/10(Pt.2))
Design and construction of experimental haul road and parking lot facilities utilizing power plant ash, 5:23495 (METC/SP—79/10(Pt.2))
Disposal of high alkaline fly ash sludge in a decoaled mine seam, 5:23505 (METC/SP—79/10(Pt.2))
Economic and environmental aspects of a new coal ash recycling/disposal process, 5:23481 (METC/SP—79/10(Pt.1))
Engineering approach for using power plant ash in a structural fill, 5:23497 (METC/SP—79/10(Pt.2))
Experience with geotechnical methods for design of flyash embankments and structural fills, 5:23498 (METC/SP—79/10(Pt.2))
Experimental cements with fly ashes, 5:23494 (METC/SP—79/10(Pt.2))
Fifth international ash utilization symposium, 5:23482 (METC/SP—79/10(Pt.2))
Fly ash/boiler slag road bases, 5:23501 (METC/SP—79/10(Pt.2))
Fly ash/cement grouts for mine backfilling, 5:23510 (METC/SP—79/10(Pt.2))
Fly ash for use in the industrial extender market, 5:23468 (METC/SP—79/10(Pt.1))
Fly ash housing scheme: an experimental project in Neyveli, 5:23471 (METC/SP—79/10(Pt.1))
Fly ash in paving and structural concrete, 5:23489 (METC/SP—79/10(Pt.2))
Government procurement of recycled products: fly ash in cement and concrete, 5:23464 (METC/SP—79/10(Pt.1))

Hillman State Park: final assessment of fly ash as a soil modifier for acidic strip mine spoil, 5:23516 (METC/SP—79/10(Pt.2))
Hydration development of fly ash cements as measured by the NMR, 5:24462 (METC/SP—79/10(Pt.2))
Impact of proposed RCRA regulations on resource recovery and utilization, 5:23463 (METC/SP—79/10(Pt.1))
Laboratory study of the effects of SO_3 and autoclave expansion of fly ash on concrete expansion and compressive strength, 5:23485 (METC/SP—79/10(Pt.2))
Lime/fly ash injection applications, 5:23508 (METC/SP—79/10(Pt.2))
New developments in the lime-soda sinter process for recovery of alumina from fly ash, 5:23466 (METC/SP—79/10(Pt.1))
New Trief cement process: what has become of Trief cement and portland industry since 1976 (Arguments in favor of new manufacturing process), 5:23493 (METC/SP—79/10(Pt.2))
Research and utilization of Indian fly ashes in cement manufacture: an overview, 5:23492 (METC/SP—79/10(Pt.2))
Role of flyash brick manufacturing in energy conservation, 5:23467 (METC/SP—79/10(Pt.1))
Role of fly ash in structural types of stabilized applications, 5:23478 (METC/SP—79/10(Pt.1))
Some properties of a highly ash-loaded cementitious binder, 5:23504 (METC/SP—79/10(Pt.2))
Specifications on fly ash for use in concrete: where we are - where should we go, 5:23484 (METC/SP—79/10(Pt.2))
The application of brown coal fly ash to road base courses. Final report (Poland), 5:24318 (PB—300879)
Use and potential for fly ash in grouting, 5:23509 (METC/SP—79/10(Pt.2))
Utilization of fly ash and coal mine refuse as a road base material. Final report 1973-77, 5:24316 (PB—300761)

FLYWHEEL ENERGY STORAGE
Testing and analysis of a fast discharge homopolar machine (fdx), 5:25059

FLYWHEEL-POWERED VEHICLES/ENERGY EFFICIENCY
Electric and Hybrid Vehicle System Research and Development Project: hybrid vehicle potential assessment. Volume V. Flywheel systems, 5:24349 (CONS—4209-T1(Vol.5))

FLYWHEEL-POWERED VEHICLES/FUEL ECONOMY
Electric and Hybrid Vehicle System Research and Development Project: hybrid vehicle potential assessment. Volume V. Flywheel systems, 5:24349 (CONS—4209-T1(Vol.5))

FLYWHEEL-POWERED VEHICLES/LIFE-CYCLE COST
Analysis of life-cycle costs and market applications of flywheel energy-storage transit vehicles. Final report 1977-78, 5:24344 (PB—300289)

FLYWHEEL-POWERED VEHICLES/MARKET
Analysis of life-cycle costs and market applications of flywheel energy-storage transit vehicles. Final report 1977-78, 5:24344 (PB—300289)

FLYWHEEL-POWERED VEHICLES/MECHANICAL ENERGY STORAGE EQUIPMENT
Hydrobus, gyrobus use brake-generated energy, 5:24350

FLYWHEEL-POWERED VEHICLES/REGENERATIVE BRAKING
Hydrobus, gyrobus use brake-generated energy, 5:24350

FLYWHEEL-POWERED VEHICLES/RESEARCH PROGRAMS
Electric and Hybrid Vehicle System Research and Development Project: hybrid vehicle potential assessment. Volume V. Flywheel systems, 5:24349 (CONS—4209-T1(Vol.5))

FLYWHEELS/COST
Low-cost flywheel demonstration program. Final report, 1 October 1977-31 December 1979, 5:24099 (CONS—5085-T2)

FLYWHEELS/DESIGN
Low-cost flywheel demonstration program. Final report, 1 October 1977-31 December 1979, 5:24099 (CONS—5085-T2)

FLYWHEELS/RESEARCH PROGRAMS
Low-cost flywheel demonstration program. Final report, 1 October 1977-31 December 1979, 5:24099 (CONS—5085-T2)

FMIT LINAC/RADIOACTIVITY
Deposition and control of ^{7}Be in liquid lithium, 5:25090 (HEDL-SA—1889-FP)

FOKKER-PLANCK EQUATION/NUMERICAL SOLUTION
Steady-state response of the electron distribution function to an applied electric field, 5:25020

FOOD INDUSTRY/ENERGY CONSERVATION
ALINET: a model for assessing energy conservation opportunities in the food processing industry. Final technical report, September 1977-December 1979, 5:24298 (DOE/CS/40021—1)

FOOD INDUSTRY/SOLAR PROCESS HEAT
Application of solar energy to continuous belt dehydration, 5:23924 (SERI/TP—333-429)
Solar-industrial heat for New York State: a case study in regional impact on economic viability, 5:23911 (SERI/TP—333-429)
Solar production of industrial process hot water (Can washing at Campbell Soup plant), 5:23918 (SERI/TP—333-429)
Solar production of low pressure steam for processing of orange juice, 5:23928 (SERI/TP—333-429)
Solar production of industrial process steam for the Lone Star Brewery, 5:23933 (SERI/TP—333-429)
Solar production of industrial process steam for potato frying, 5:23935 (SERI/TP—333-429)

FOOD PROCESSING/ENERGY CONSUMPTION
ALINET: a model for assessing energy conservation opportunities in the food processing industry. Final technical report, September 1977-December 1979, 5:24298 (DOE/CS/40021—1)
Residential energy consumption survey: characteristics of the housing stock and households, 5:24253 (DOE/EIA—0207/2)

FOOD PROCESSING/GEOTHERMAL PROCESS HEAT
Potato processing, 5:24000

FOREST LITTER/ENZYME ACTIVITY
Effects of divalent metal chlorides on respiration and extractable enzymatic activities of douglas-fir needle litter, 5:24769

FOREST LITTER/RESPIRATION
Effects of divalent metal chlorides on respiration and extractable enzymatic activities of douglas-fir needle litter, 5:24769

FORESTS/RESOURCE POTENTIAL
Potentialities of forest biomass as sources of energy, 5:23838 (SRO—1015-T1)

FORMALDEHYDE/MONITORING
Formaldehyde monitoring program: development of sampling and analysis procedures. Report to the Consumer Product Sampling Commission, 5:24592 (DOE/TIC—11203)

FORMED COKE PROCESSES
Method of producing form coke (Patent), 5:23411

FORT SHEVCHENKO REACTOR
See BN-350 REACTOR

FOSSIL FUELS
See also COAL
NATURAL GAS
OIL SANDS
OIL SHALES
PEAT
PETROLEUM
SHALE OIL
SYNTHETIC FUELS

FOSSIL FUELS/MUTAGEN SCREENING
Mutagenicity testing of aqueous materials from alternate fuel production, 5:24765 (CONF-790663—3)

FOSSIL-FUEL POWER PLANTS
See also ELECTRIC UTILITIES

FOSSIL-FUEL POWER PLANTS/AIR POLLUTION CONTROL
Bibliography of the Interagency Energy/Environment R and D Program, 5:24593 (EPA—600/9-79-015)
Fiscal Year 1977 Research Program Abstracts of the Interagency Energy/Environment R & D Program, 5:24594 (EPA—600/9-79-016)

FOSSIL-FUEL POWER PLANTS/ASHES
Bottom ash lightweight aggregate, 5:23472 (METC/SP—79/10(Pt.1))
CEGB overview (1966 to 1978), 5:23461 (METC/SP—79/10(Pt.1))
Composition and properties of Kentucky power plant ash, 5:24035 (METC/SP—79/10(Pt.1))

FOSSIL-FUEL POWER PLANTS/ENVIRONMENTAL IMPACT STATEMENTS
The Environmental Protection Agency and the Kaiparowits Power Project: a case study of EPA's performance of its environmental review responsibilities, 5:24028 (PB—300391)

FOSSIL-FUEL POWER PLANTS/ENVIRONMENTAL IMPACTS
Climate and energy: a comparative assessment of the Satellite Power System (SPS) and alternative energy technologies, 5:23798 (DOE/ER—0050)
Comparative assessment of environmental welfare issues associated with the satellite power system (SPS) and alternative technologies, 5:23849 (DOE/ER—0055)
Environmental problems of the uranium mining and milling industry, 5:23755
Observations on boron release from coal-fired power plants, 5:23532

FOSSIL-FUEL POWER PLANTS/FLUE GAS
Effectiveness and cost of air pollution control for coal-fired electric power plants in the west, 5:24037 (PB—300515)
Impact of ammonia utilization by NOx flue gas treatment processes. Final report August 1977-November 1978, 5:24038 (PB—300596)
Options for the collection and disposal of carbon dioxide, 5:24036 (ORNL—5657)

FOSSIL-FUEL POWER PLANTS/FLY ASH
Field retention time studies of ash settling ponds, 5:23474 (METC/SP—79/10(Pt.1))
Responsibility for quality control and quality assurance of fly ash, 5:23462 (METC/SP—79/10(Pt.1))

FOSSIL-FUEL POWER PLANTS/HEALTH HAZARDS
Health and safety. Preliminary comparative assessment of the satellite power system (SPS) and other energy alternatives, 5:23847 (DOE/ER—0053)
FOSSIL-FUEL POWER PLANTS/NET ENERGY
Comparative analysis of net energy balance for satellite power systems (SPS) and other energy systems, 5:23850 (DOE/ER—0056)
FOSSIL-FUEL POWER PLANTS/POLLUTION CONTROL EQUIPMENT
Effectiveness and cost of air pollution control for coal-fired electric power plants in the west, 5:24037 (PB—300515)
Impact of ammonia utilization by NOx flue gas treatment processes. Final report August 1977-November 1978, 5:24038 (PB—300596)
FOSSIL-FUEL POWER PLANTS/RETROFITTING
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume I. Text, 5:24322 (COO—4975-(Vol.1)(Text))
FOSSIL-FUEL POWER PLANTS/SITE SELECTION
Selected regulatory issues affecting coal transportation requirements, 5:23550
FOSSIL-FUEL POWER PLANTS/SLAGS
Slag: a useful form of ash, 5:24312 (METC/SP—79/10(Pt.2))
FOUNDRIES/AIR POLLUTION
Evaluation of stationary source particulate measurement methods. Volume V. Secondary lead smelters. Interim report oct 73-June 1977, 5:24608 (PB—300337)
FRACTURED RESERVOIRS/MAPPING
Borehole survey instrumentation development for geothermal applications, 5:23988 (LA-UR—80-670)
FRACTURES/IN-SITU RETORTING
Post-burn study of the Rock Springs, Site 9 in situ retorting experiment, 5:23630
FRACTURES/MATHEMATICAL MODELS
Explosively produced fracture of oil shale. Annual report, April 1978-March 1979, 5:23619 (LA—8104-PR)
FRACTURES/STRAINS
Explosively produced fracture of oil shale. Annual report, April 1978-March 1979, 5:23619 (LA—8104-PR)
FRACTURES/STRESSES
Explosively produced fracture of oil shale. Annual report, April 1978-March 1979, 5:23619 (LA—8104-PR)
FRANCE/SOLAR ENERGY
Solar energy in Europe, 5:23796
FREE RADICALS
See RADICALS
FREIGHT
See CARGO
FREONS/PHOTOCHEMICAL REACTIONS
Deuterium separation at high pressure by nanosecond CO_2 laser multiple-photon dissociation, 5:24497
FRESH WATER ECOSYSTEMS
See AQUATIC ECOSYSTEMS
FRESNEL LENS/DESIGN
Image collapsing concentrators. Interim scientific report No. 2, 5:23951 (DOE/CS/34163—2)
FRICTION/MEASURING INSTRUMENTS
Study of the interactions between friction, wear and system rigidity. Progress report, July 1, 1979-June 30, 1980, 5:24509 (DOE/ER/10471—1)
FRM DEVICES (THERMONUCLEAR)
See FIELD-REVERSED MIRROR REACTORS
FRUCTOSE/PRESERVATION
Carbohydrate crops as a renewable resource for fuels production. Volume III. Juice preservation, 5:23833 (BMI—2031(Vol.3))
FRUITS
(Edible parts of plants only.)
FRUITS/SOLAR DRYING
Analysis of the operation of an industrial drying solar system, 5:23921 (SERI/TP—333-429)
FTR REACTOR
See FFTF REACTOR
FUEL ADDITIVES
Polyolefin/acylated poly(alkyleneamine) two component fuel additive (Patent), 5:24358
FUEL ASSEMBLIES/HEAT TRANSFER
Heat-transfer in a partially-blocked sodium-cooled rod bundle (LMFBR), 5:24053 (CONF-791205—23)
FUEL ASSEMBLIES/HYDRAULICS
Heat-transfer in a partially-blocked sodium-cooled rod bundle (LMFBR), 5:24053 (CONF-791205—23)
FUEL CANS/DECONTAMINATION
Cladding hull decontamination and densification process. Part 1. The prototype cladding hull decontamination system, 5:23702 (PNL—3166(Pt.1))
FUEL CANS/MODIFICATIONS
Device and method for shortening reactor process tubes (Patent), 5:24066
FUEL CELL CATALYSTS
See ELECTROCATALYSTS
FUEL CELL POWER PLANTS
Fuel cells for electric utility and transportation applications, 5:24234 (BNL—27452)
FUEL CELLS
See also ACID ELECTROLYTE FUEL CELLS
ALCOHOL FUEL CELLS
HIGH-TEMPERATURE FUEL CELLS
HYDROGEN FUEL CELLS
FUEL CELLS/INVERTERS
Power conditioners and fuel cell inverters, 5:24242
FUEL CELLS/MEETINGS
Twenty-eighth power sources symposium (Atlantic City, NJ, June 12-15, 1978), 5:24102
FUEL CELLS/POISONING
Diagnostic techniques for performance evaluation of fuel cells. I. Comparison of carbon monoxide tolerance of selected anodes, 5:24239
FUEL CELLS/POWER CONDITIONING CIRCUITS
Power conditioners and fuel cell inverters, 5:24242
FUEL CELLS/REVIEWS
Fuel cells for electric utility and transportation applications, 5:24234 (BNL—27452)
FUEL COOLING INSTALLATIONS
See SPENT FUEL STORAGE
FUEL CYCLE
See also THORIUM CYCLE
FUEL CYCLE/REVIEWS
Overview of nuclear fuel cycle, 5:23671 (CONF-791185—3)
FUEL ELEMENTS
See also FUEL PINS
FUEL RODS
SPENT FUEL ELEMENTS
FUEL ELEMENTS/COST
ACFAC: a cash flow analysis code for estimating product price from an industrial operation, 5:24069 (ORNL/TM—7150)
FUEL GAGES/SYNTHESIS
Conversion of coal-based methanol to ethylene and a gaseous fuel. Final report 1 October 1975-30 September 1978, 5:23773 (PB—301256)
FUEL GAS
See also HIGH BTU GAS
INTERMEDIATE BTU GAS
LOW BTU GAS
FUEL GAS/CHEMICAL REACTION YIELD
Method for converting a reaction mixture consisting of hydrocarbon-containing fuel and an oxygen-containing gas into a fuel gas (Patent), 5:23771
FUEL GAS/COMBUSTION
Method for converting a reaction mixture consisting of hydrocarbon-containing fuel and an oxygen-containing gas into a fuel gas (Patent), 5:23771
FUEL GAS/COMBUSTION PRODUCTS
Burner equipment and operation thereof, 5:24506
FUEL GAS/DESULFURIZATION
Holmes-Stretford process for desulfurization of tail gases from acid-gas systems, 5:23415
FUEL GAS/HOT GAS CLEANUP
Glass-fly ash from a new hot gas clean-up process, 5:23413 (METC/SP—79/10(Pt.1))
FUEL GAS/PURIFICATION
Low/medium Btu gasification: a summary of applicable EPA regulations, 5:23531
FUEL GAS/SYNTHESIS
Partial oxidation process (Patent), 5:23772
FUEL LOADING
See REACTOR FUELING
FUEL OILS/COMBUSTION
Theoretical studies on heterogeneous combustion. Progress report, March 1, 1979-February 29, 1980, 5:24022 (COO—4433-3)
FUEL OILS/EMULSIONS
Evaluation of coal/oil/water slurry (COWS) emulsions produced by an on-line cavitation emulsification process, 5:24023 (FE—3162-T1)
FUEL PINS/TEMPERATURE GRADIENTS
TEMP: a computer code to calculate fuel pin temperatures during a transient (LMFBR), 5:24093 (HEDL-TME—75-85)
FUEL RACKS/PERFORMANCE
Water loss in fast project interim fuel storage rack, 5:24092 (EGG-FM—5078)
FUEL REPROCESSING PLANTS
See also WEST VALLEY PROCESSING PLANT
FUEL REPROCESSING PLANTS/RADIOACTIVE WASTE PROCESSING
Cladding hull decontamination and densification process. Part 1. The prototype cladding hull decontamination system, 5:23702 (PNL—3166(Pt.1))

High level nuclear waste, 5:23717 (DP-MS—80-39)
FUEL REPROCESSING PLANTS/SAFEGUARDS
Implementation of the engineering safeguards program (ESP) into nuclear fuel recycle facilities, 5:23759 (CONF-790707—36)
FUEL RODS/ENCAPSULATION
Method and means of packaging nuclear fuel rods for handling (Patent), 5:24076
FUEL RODS/EXPANSION
Device and method for shortening reactor process tubes (Patent), 5:24066
FUEL RODS/TRANSPORT
Method and means of packaging nuclear fuel rods for handling (Patent), 5:24076
FUEL SLURRIES/EMULSIFICATION
Evaluation of coal/oil/water slurry (COWS) emulsions produced by an on-line cavitation emulsification process, 5:24023 (FE—3162-T1)
FUEL SLURRIES/EMULSIONS
Evaluation of coal/oil/water slurry (COWS) emulsions produced by an on-line cavitation emulsification process, 5:24023 (FE—3162-T1)
FUEL SLURRIES/PHYSICAL PROPERTIES
Thermophysical properties of coal liquids. Second quarterly technical status report, January 1-March 31, 1980, 5:23451 (BMI—2053)
FUEL SUBSTITUTION/EMERGENCY PLANS
Analysis of Federal Government energy emergency programs. Energy policy study, Volume 5. AR/EI-80-05, 5:24195 (DOE/EIA—0201/5)
FUELS
See also AVIATION FUELS
DIESEL FUELS
FOSSIL FUELS
FUEL GAS
FUEL OILS
FUEL SLURRIES
GASOLINE
HYDROGEN FUELS
JET ENGINE FUELS
SOLVENT-REFINED COAL
SYNTHETIC FUELS
THERMONUCLEAR FUELS
FUELS/COMPARATIVE EVALUATIONS
Coal, 5:23533 (CONF-790949—3)
Current status of the Texaco coal gasification process, 5:23785
Future availability of feedstocks for ammonia production (To 2000), 5:23781
FULL-SERVE STATIONS
See GASOLINE SERVICE STATIONS
FUMES
See AEROSOLS
FUNGI
See also YEASTS
FUNGI/AEROSOL MONITORING
Airborne aeroallergen measurements in Houston, Texas. Final report, 5:24602 (PB—299643)
FUNGI/PATHOGENESIS
Race-specific molecules that protect soybeans from Phytophthora megasperma var. sojae, 5:24728
FURNACES
See also BLAST FURNACES
FURNACES/AIR POLLUTION CONTROL
High efficiency furnace with low pollution emissions (Patent), 5:24259
FURNACES/EFFICIENCY
High efficiency furnace with low pollution emissions (Patent), 5:24259
FUSION REACTORS
See THERMONUCLEAR REACTORS

G

GADOLINIUM/COSTER-KRONIG TRANSITIONS
L/sub 2,3/-subshell x-ray fluorescence and Coster-Kronig yields at Z=64 and 67, 5:24815
GADOLINIUM/EXCHANGE INTERACTIONS
k dependence of the conduction-electron—local-moment exchange interaction in the atomic and covalent-mixing limits, 5:24402
GADOLINIUM 150/HIGH SPIN STATES
Phenomena at very high spins (Approx. 70 h-bar; review), 5:24939 (LBL—10645)
GALL STONES
See BILIARY TRACT
GALLBLADDER
See BILIARY TRACT
GALLIUM/BONDING
Bonding of Al and Ga to GaAs(110), 5:24381
GALLIUM/INTERFACES
Bonding of Al and Ga to GaAs(110), 5:24381
GALLIUM ARSENIDE SOLAR CELLS/FABRICATION
Advanced photovoltaic concentrator cells. Quarterly technical progress report No. 1, August 28, 1979-November 30, 1979, 5:23818 (DSE—4042-T30)
GALLIUM ARSENIDE SOLAR CELLS/GRADED BAND GAPS
Advanced photovoltaic concentrator cells. Quarterly technical progress report No. 1, August 28, 1979-November 30, 1979, 5:23818 (DSE—4042-T30)
GALLIUM ARSENIDES/ANNEALING
Steady-state thermally annealed GaAs with room-temperature-implanted Si, 5:24479
GALLIUM ARSENIDES/BONDING
Bonding of Al and Ga to GaAs(110), 5:24381
GALLIUM ARSENIDES/INTERFACES
Bonding of Al and Ga to GaAs(110), 5:24381
GALLIUM ARSENIDES/ION IMPLANTATION
Steady-state thermally annealed GaAs with room-temperature-implanted Si, 5:24479
GAMMA CAMERAS/PERFORMANCE TESTING
Measurements of the performance parameters of gamma cameras: Part II. Final report, 5:24562 (PB—301041)
GAMMA DETECTION/GAMMA CAMERAS
Measurements of the performance parameters of gamma cameras: Part II. Final report, 5:24562 (PB—301041)
GAMMA DETECTION/PLASTIC SCINTILLATION DETECTORS
Absolute calibration of a prompt gamma ray detector for intense bursts of protons, 5:24563 (NRL-MR—4171)
GARRETT PROCESS
See OXY MODIFIED IN-SITU PROCESS
GAS BURNERS/PERFORMANCE TESTING
R and D activities in pulse combustion at BNL, 5:24248 (BNL—27602)
GAS COMPRESSORS/FOULING
Operating experience on a 1,000-ton/day ammonia plant at Modderfontein, 5:23790
GAS COMPRESSORS/RELIABILITY
Large oxygen plant economics and reliability, 5:23786
GAS COOLANTS
See GASES
GAS COOLED FAST BREEDER REACTOR
See GCFR REACTOR
GAS ENGINES
See INTERNAL COMBUSTION ENGINES
GAS GENERATORS/DESIGN
Method for converting a reaction mixture consisting of hydrocarbon-containing fuel and an oxygen-containing gas into a fuel gas (Patent), 5:23771
GAS LASERS
See also CARBON DIOXIDE LASERS
GAS LASERS/AMPLIFIERS
Evaluation of a high power submillimeter pulsed laser system, 5:24993 (CONF-800138—1)
GAS LASERS/ENERGY ABSORPTION
Determination of spatial energy deposition in e-beam-pumped laser cells by pressure measurements, 5:24527
GAS LASERS/LASER MIRRORS
Krypton fluoride laser mirror study. Final report, October 1978-November 1979, 5:24521 (DOE/DP/40001—1)
GAS LASERS/OPTICAL PROPERTIES
Optical extraction characteristics of homogeneously broadened cw lasers with nonsaturating lasers, 5:24524
GAS LASERS/RESEARCH PROGRAMS
Applied quantum chemistry advanced laser development. Final progress report, 1 October 1978-30 September 1979, 5:24522 (DOE/DP/40100—1)
Krypton fluoride laser mirror study. Final report, October 1978-November 1979, 5:24521 (DOE/DP/40001—1)
GAS LASERS/WINDOWS
Krypton fluoride laser mirror study. Final report, October 1978-November 1979, 5:24521 (DOE/DP/40001—1)
GAS SPILLS/MATHEMATICAL MODELS
Dynamics and modeling of heavier-than-air, cold gas releases, 5:23612 (UCRL—15224)
GAS SPILLS/THERMODYNAMICS
Dynamics and modeling of heavier-than-air, cold gas releases, 5:23612 (UCRL—15224)
GAS STATIONS
See GASOLINE SERVICE STATIONS

GAS TURBINE ENGINES/CATALYTIC COMBUSTORS
Effect of catalyst length and downstream reaction distance on catalytic combustor performance, 5:24337 (DOE/NASA/1040—80/14)
GAS TURBINE ENGINES/COMBUSTORS
Durability testing at 5 atmospheres of advanced catalysts and catalyst supports for gas turbine engine combustors, 5:24338 (DOE/NASA/9416—80/2)
GAS TURBINE ENGINES/EXHAUST GASES
Durability testing at 5 atmospheres of advanced catalysts and catalyst supports for gas turbine engine combustors, 5:24338 (DOE/NASA/9416—80/2)
GAS TURBINE POWER PLANTS/GRANULAR BED FILTERS
Granular filter (Patent), 5:24021
GAS TURBINES/CORROSION PROTECTION
High temperature gas turbine engine component materials testing program: Task I. Fireside I. Final report, 5:24017 (FE—1765-44)
GAS TURBINES/ECONOMIC ANALYSIS
Steam injected gas turbine study: an economic and thermodynamic appraisal. Final report, 5:24016 (EPRI-NP—1186)
GAS TURBINES/MATERIALS
Ceramics Technology Readiness Development Program. Phase I: conceptual designs and material screening. Final report, 5:24019 (FE—2786-38)
GAS TURBINES/MATERIALS TESTING
Long-Term Materials Test Program. Quarterly progress report, October-December 1979, 5:24015 (DOE/ET/15457—4)
Long Term Materials Test Program. Quarterly progress report, January-March 1980, 5:24011 (DOE/ET/15457—10)
GAS TURBINES/PERFORMANCE
Steam injected gas turbine study: an economic and thermodynamic appraisal. Final report, 5:24016 (EPRI-NP—1186)
GAS TURBINES/PERFORMANCE TESTING
Development of high-temperature turbine subsystem technology to a technology readiness status, Phase II. Quarterly report, January-March 1980, 5:24018 (FE—1806-86)
GAS TURBINES/POLLUTION CONTROL EQUIPMENT
Environmental assessment of stationary source NOx control technologies. Annual report no. 2, June 1977-June 1978, 5:24547 (PB—300469)
GAS TURBINES/PROTECTIVE COATINGS
High temperature gas turbine engine component materials testing program: Task I. Fireside I. Final report, 5:24017 (FE—1765-44)
GAS TURBINES/RESEARCH PROGRAMS
Development of high-temperature turbine subsystem technology to a technology readiness status, Phase II. Quarterly report, January-March 1980, 5:24018 (FE—1806-86)
GAS TURBINES/STEAM INJECTION
Steam injected gas turbine study: an economic and thermodynamic appraisal. Final report, 5:24016 (EPRI-NP—1186)
GAS TURBINES/THERMAL EFFICIENCY
Ceramics Technology Readiness Development Program. Phase I: conceptual designs and material screening. Final report, 5:24019 (FE—2786-38)
GASEOUS WASTES
See also EXHAUST GASES
FLUE GAS
GASEOUS WASTES/CHEMICAL COMPOSITION
Environmental research on a modified in situ oil shale task process. Progress report, 5:23660 (DOE/EV—0078)
Evaluation of stationary source particulate measurement methods. Volume V. Secondary lead smelters. Interim report oct 73-June 1977, 5:24608 (PB—300337)
GASEOUS WASTES/DESULFURIZATION
Holmes-Stretford process for desulfurization of tail gases from acid-gas systems, 5:23415
Method for recovering concentrated sulphur dioxide from waste gases containing sulphur dioxide (Patent), 5:23513
GASEOUS WASTES/HEALTH HAZARDS
Environmental research on a modified in situ oil shale task process. Progress report, 5:23660 (DOE/EV—0078)
GASEOUS WASTES/MONITORING
Continuous air pollution source monitoring systems, 5:24616 (PB—300930)
GASEOUS WASTES/TEMPERATURE MEASUREMENT
Evaluation of stationary source particulate measurement methods. Volume III. Gas temperature control during method 5 sampling. Interim report oct 73-February 1977, 5:24607 (PB—300336)
GASES
See also COAL GAS
FUEL GAS
NATURAL GAS
SHALE GAS
SYNTHESIS GAS
GASES/DIFFUSION
New technique for determining the parameters of gas permeation through solids, 5:24494 (GEPP-OP—474a)
GASES/SEPARATION PROCESSES
Effect of the degree of hydration of the adsorbent on the chromatographic analysis of common gases, 5:24493 (DP-TR—9)
GASOLINE/ALLOCATIONS
Analysis of Federal Government energy emergency programs. Energy policy study, Volume 5. AR/EI-80-05, 5:24195 (DOE/EIA—0201/5)
GASOLINE/CATALYTIC CRACKING
Hydrotreating of pyrolysis gasoline (Patent), 5:23594
GASOLINE/RETAIL PRICES
State of competition in gasoline marketing. The effects of refiner operation at retail (a study required by Title III of the Petroleum Marketing Practices Act), 5:23600 (DOE/PE—0019(Vol.1))
GASOLINE/WHOLESALE PRICES
State of competition in gasoline marketing. The effects of refiner operation at retail (a study required by Title III of the Petroleum Marketing Practices Act), 5:23600 (DOE/PE—0019(Vol.1))
GASOLINE SERVICE STATIONS/AIR POLLUTION MONITORS
Vapor emission recovery and measuring method and vapor recovery collection boot (Patent), 5:24626
GASTEROPODS
See MOLLUSCS
GAUGE INVARIANCE/DUALITY
Dual formulation of non-Abelian gauge theories, 5:24856
GAUGE INVARIANCE/RENORMALIZATION
Reggeization of elementary fermions in arbitrary renormalizable gauge theories, 5:24858
GCFR REACTOR/SHIELDING
Analysis of the initial shielding design for the upflow gas-cooled fast reactor (GCFR), 5:24059 (ORNL/TM—7246)
GENE MUTATIONS/DIAGNOSIS
Validation of conditions for efficient detection of HPRT and APRT mutations in suspension-cultured Chinese hamster ovary cells, 5:24710
GENE MUTATIONS/GENETIC MAPPING
Mutator affecting the region of the iso-1-cytochrome c gene in yeast, 5:24712
GENE MUTATIONS/REVERTANTS
Ultraviolet-induced reversion of cyc1 alleles in radiation-sensitive strains of yeast. III. rev 3 mutant strains, 5:24745
GENERATORS (ELECTRIC)
See ELECTRIC GENERATORS
GENERATORS (PULSE)
See PULSE GENERATORS
GENERATORS (STEAM)
See STEAM GENERATORS
GENES/RADIOSENSITIVITY
Ultraviolet-induced reversion of cyc1 alleles in radiation-sensitive strains of yeast. III. rev 3 mutant strains, 5:24745
GENETICS/MATHEMATICAL MODELS
Study of mathematical models of mutation and selection in multi-locus systems. Annual progress report, April 1, 1979-March 31, 1980, 5:24667 (DOE/EV/02472—6)
GEOCHEMICAL SURVEYS
Review of geochemical measurement techniques for a nuclear waste repository in bedded salt, 5:23748 (UCID—18664)
GEOCHEMICAL SURVEYS/DATA COMPILATION
Hydrogeochemical and stream sediment reconnaissance basic data for Dickinson NTMS Quadrangle, North Dakota, 5:23689 (GJBX—99(80))
Hydrogeochemical and stream sediment reconnaissance basic data for Marquette NTMS Quadrangle, Michigan, 5:23693 (GJBX—106(80))
GEOLOGIC DEPOSITS
See also COAL DEPOSITS
NATURAL GAS DEPOSITS
OIL SAND DEPOSITS
OIL SHALE DEPOSITS
PETROLEUM DEPOSITS
SALT DEPOSITS
URANIUM DEPOSITS
GEOLOGIC DEPOSITS/RADIONUCLIDE MIGRATION
Waste Isolation Safety Assessment Program. Technical progress report for FY-1978, 5:23737 (PNL—2874)
GEOPRESSURED SYSTEMS/ENVIRONMENTAL IMPACTS
Environmental overview of geopressured-geothermal development: Texas Gulf Coast, 5:23995 (UCRL—15094)
GEOPRESSURED SYSTEMS/RESOURCE DEVELOPMENT
Environmental overview of geopressured-geothermal development: Texas Gulf Coast, 5:23995 (UCRL—15094)

GEORGIA/ELECTRIC UTILITIES
Analysis of environmental factors affecting technology deployment: a case study, 5:24027 (DOE/RA/10001—T1)
GEORGIA/MAGNETIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
Aerial radiometric and magnetic survey: Phenix City National Topographic Map, Alabama/Georgia, Southeast US Project 1979, 5:23691 (GJBX—101(80))
GEORGIA/RADIOMETRIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
Aerial radiometric and magnetic survey: Phenix City National Topographic Map, Alabama/Georgia, Southeast US Project 1979, 5:23691 (GJBX—101(80))
GEOTHERMAL ENERGY/FINANCIAL INCENTIVES
Selected federal tax and non-tax subsidies for energy use and production. Energy policy study, Volume 6. AR/EA/80-01, 5:24202 (DOE/EIA—0201/6)
GEOTHERMAL ENERGY/INFORMATION SYSTEMS
Computerized international geothermal information systems, 5:23979 (LBL—10615)
GEOTHERMAL ENERGY CONVERSION/AIR POLLUTION CONTROL
State-of-the-art hydrogen sulfide control for geothermal energy systems: 1979, 5:23993 (DOE/EV—0068)
GEOTHERMAL FLUIDS
See also NATURAL STEAM
GEOTHERMAL FLUIDS/REMOVAL
Process for purifying geothermal steam (Patent), 5:23992
GEOTHERMAL HEATING SYSTEMS/ECONOMIC ANALYSIS
Geothermal Energy Market Study on the Atlantic Coastal Plain. Geothermal Energy Market penetration: development of a model for the residential sector, 5:23998 (DOE/ET/27025—T1)
GEOTHERMAL HEATING SYSTEMS/MARKET
Geothermal Energy Market Study on the Atlantic Coastal Plain. Geothermal Energy Market penetration: development of a model for the residential sector, 5:23998 (DOE/ET/27025—T1)
GEOTHERMAL POWER PLANTS/LAND USE
Land use siting considerations for hydrothermal energy facilities, 5:23989 (CONF-800517—4)
GEOTHERMAL PROCESS HEAT/ECONOMIC ANALYSIS
Potato processing, 5:24000
GEOTHERMAL RESOURCES/COMMERCIALIZATION
Nevada geothermal commercialization planning. Quarterly progress report, January 1, 1980-March 31, 1980, 5:23980 (DOE/RA/50076—T1)
GEOTHERMAL RESOURCES/RESOURCE DEVELOPMENT
Nevada geothermal commercialization planning. Semi-annual progress report, January 1, 1979-June 30, 1979, 5:23990 (DOE/ID/12019—1)
GEOTHERMAL STEAM
See NATURAL STEAM
GEOTHERMAL SYSTEMS
See also GEOPRESSURED SYSTEMS
HOT-DRY-ROCK SYSTEMS
HYDROTHERMAL SYSTEMS
GEOTHERMAL SYSTEMS/ENVIRONMENTAL IMPACTS
Geothermal environmental impact assessment: subsurface environmental assessment for four geothermal systems, 5:23994 (PB—300851)
GEOTHERMAL WELLS/CORING EQUIPMENT
Research and development of a high-pressure waterjet coring device for geothermal exploration and drilling. Final report, February 1976-October 1977, 5:23997 (RLO—2325)
GEOTHERMAL WELLS/LINERS
High temperature concrete composites containing organosiloxane crosslinked copolymers (Patent), 5:24439
Polymer concrete composites for the production of high strength pipe and linings in high temperature corrosive environments (Patent), 5:24444
GEOTHERMAL WELLS/LITHOLOGY
In-progress geologic map of Canon de San Diego, Jemez Springs, New Mexico, and lithologic log of Jemez Springs geothermal well, 5:23984 (LA—8276-MAP)
GEOTHERMAL WELLS/PERFORMANCE
Evaluation of city well 1, Klamath Falls, Oregon, 5:23999 (LBL—10848)
GEOTHERMAL WELLS/TEMPERATURE MEASUREMENT
Chemical temperature indicators for geothermal applications. Final report, 5:23996 (DGE—4008-F)
GEOTHERMAL WELLS/WELL DRILLING
Research and development of a high-pressure waterjet coring device for geothermal exploration and drilling. Final report, February 1976-October 1977, 5:23997 (RLO—2325)
GEOTHERMAL WELLS/WELL LOGGING
Geophysical logging case history of the Raft River geothermal system, Idaho, 5:23987 (LA—8252-MS)
GERMANIUM/ABSORPTIVITY
Characterization of black Ge selective absorbers, 5:24411
GERMANIUM/ETCHING
Characterization of black Ge selective absorbers, 5:24411
GERMANIUM/FINE STRUCTURE
Extended x-ray absorption fine structure of NaBr and Ge at high pressure, 5:24465
GERMANIUM/SPUTTERING
Characterization of black Ge selective absorbers, 5:24411
GERMANIUM ALLOYS/FLEXIBILITY
Method of manufacturing a niobium-aluminum-germanium superconductive material (Patent), 5:24362
GERMANIUM ALLOYS/SUPERCONDUCTIVITY
LASL Nb_3Ge conductor development. Fourteenth quarterly progress report, October 1-December 31, 1979, 5:24969 (LA—8320-PR)
GERMANIUM ALLOYS/SURFACE COATING
Method of manufacturing a niobium-aluminum-germanium superconductive material (Patent), 5:24362
GERMANY (FEDERAL REPUBLIC)
See FEDERAL REPUBLIC OF GERMANY
GEYSERS GEOTHERMAL FIELD/ENVIRONMENTAL IMPACTS
Geothermal environmental impact assessment: subsurface environmental assessment for four geothermal systems, 5:23994 (PB—300851)
GEYSERS GEOTHERMAL FIELD/RESOURCE DEVELOPMENT
Geothermal environmental impact assessment: subsurface environmental assessment for four geothermal systems, 5:23994 (PB—300851)
GIANT RESONANCE/EXCITATION
Excitation of giant resonances via charge exchange reactions, 5:24901 (CONF-7910148—1)
GLASS
Effect of container preparation on the growth of protium and methane impurities into tritium gas, 5:25095
GLASS/ACTIVATION ANALYSIS
Exploding-pusher-tamper areal density measurement by neutron activation, 5:23761
GLASS/MATERIALS RECOVERY
Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation. Volume II. working papers, 5:24329 (PB—300848)
Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation, 5:24330 (PB—300849)
Refractory particles in cullet recovered from municipal refuse. Technical report, 5:24328 (PB—300523)
GLASS/MECHANICAL PROPERTIES
Properties of a solar alumina-borosilicate sheet glass, 5:23960 (SERI/TP—334-565)
GLASS/OPTICAL PROPERTIES
Properties of a solar alumina-borosilicate sheet glass, 5:23960 (SERI/TP—334-565)
GLASS/PHYSICAL RADIATION EFFECTS
Effect of radiation on the physical properties of borosilicate glasses, 5:24480
GLASS/PRODUCTION
Properties of a solar alumina-borosilicate sheet glass, 5:23960 (SERI/TP—334-565)
GLASS/REFRACTIVITY
Effect of radiation on the physical properties of borosilicate glasses, 5:24480
GLASS/THERMAL EXPANSION
Effect of radiation on the physical properties of borosilicate glasses, 5:24480
GLAUBER'S SALT
See SODIUM SULFATES
GLAZING MATERIALS
Properties of a solar alumina-borosilicate sheet glass, 5:23960 (SERI/TP—334-565)
GLAZING MATERIALS/MATERIALS
National solar optical materials program plan: an overview, 5:23961 (SERI/TP—641-619)
GLIOBLASTOMAS
See NEOPLASMS
GLOBIN/GENES
Assignment of human β-, γ-, and δ-globin genes to the short arm of chromosome 11 by chromosome sorting and DNA restriction enzyme analysis, 5:24711

GLUCOPROTEINS/IMMUNE REACTIONS
Race-specific molecules that protect soybeans from Phytophthora megasperma var. sojae, 5:24728
GLUCOSE/PRESERVATION
Carbohydrate crops as a renewable resource for fuels production. Volume III. Juice preservation, 5:23833 (BMI—2031(Vol.3))
GLUON MODEL
(Describes the interaction of a neutral massive vector field with a massive spinor field.)
Evidence for quarks and gluons, 5:24970 (LA—8310-MS)
GLUONS/BOUND STATE
Heavy quarks and new particles, 5:24868
GLYCINE HISPIDA/DISEASE RESISTANCE
Race-specific molecules that protect soybeans from Phytophthora megasperma var. sojae, 5:24728
GLYCOLS/POLYMERIZATION
Synthesis of thermosetting polymers from the by-products of coal conversion processes, 5:23450
GOLD/ACTIVATION ANALYSIS
Instrumental analysis of trace elements in thumbnails of human subjects, 5:24484
GOLD/EXCHANGE INTERACTIONS
k dependence of the conduction-electron—local-moment exchange interaction in the atomic and covalent-mixing limits, 5:24402
GOLD/PHOTON TRANSPORT
Z dependence of the laser-intensity threshold for inhibited electron thermal conduction, 5:24951
GOLD 197 TARGET/MUON REACTIONS
Nuclear disintegration of some complex nuclei by 60-MeV muons, 5:24899
GOLD 197 TARGET/NEON 20 REACTIONS
Exactly central heavy-ion collisions by nuclear hydrodynamics, 5:24928
Target residues from the reaction of 8 GeV ^{20}Ne with ^{181}Ta and ^{197}Au, 5:24926
GOLD ISOTOPES/ENERGY LEVELS
Use of systematics in the interpretation of nuclear structure far from the beta-stable region, 5:24930 (CONF-790976—9)
GOVERNMENT POLICIES
See also ENERGY POLICY
GOVERNMENT POLICIES/ECONOMIC IMPACT
Balancing the objectives of clean air and economic growth: regulated markets in emission reductions. Interim report, 5:24639 (PB—300835)
GRAIN BOUNDARIES/DIFFUSION
Grain-boundary diffusion in uranium dioxide: the correlation between sintering and creep and a reinterpretation of creep mechanism, 5:24432
GRANITES/ACOUSTIC MONITORING
Between-hole acoustic surveying and monitoring of a granitic rock mass, 5:23731 (LBL—10483)
GRANITES/ROCK MECHANICS
Between-hole acoustic surveying and monitoring of a granitic rock mass, 5:23731 (LBL—10483)
GRANULAR BED FILTERS/EFFICIENCY
Granular filter (Patent), 5:24021
GRANULAR BED FILTERS/PERFORMANCE
Granular filter (Patent), 5:24021
Solid fuel fired gas turbine system having continuously regenerating granular filter (Patent), 5:24020
GRAPHITE/ELECTRONIC STRUCTURE
Band structure and thermodynamic properties of He atoms near a graphite surface, 5:24471
GRAPHITE/FABRICATION
Method for making hot-pressed fiber-reinforced carbide-graphite composite (Patent), 5:24455
GRAPHITE/HOT PRESSING
Method for making hot-pressed fiber-reinforced carbide-graphite composite (Patent), 5:24455
GRAPHITE/PHYSICAL RADIATION EFFECTS
Development and laboratory testing of low Z refractory coatings for fusion reactor limiters, 5:25093 (SAND—79-2409C)
GRAPHITE/ROUGHNESS
Band structure and thermodynamic properties of He atoms near a graphite surface, 5:24471
GRAPHITE/TEXTILES
Coated woven materials and method of preparation (Patent), 5:24453
GRAPHITE FIBERS
See CARBON FIBERS
GRAVITATION/SYMMETRY BREAKING
Horizon problem and the broken-symmetric theory of gravity, 5:24799
GRAVITATIONAL INTERACTIONS/UNIFIED GAUGE MODELS
Dynamical criteria for a unified gauge theory (including gravity), 5:24876 (COO—3075-224)
GREAT BRITAIN
See UNITED KINGDOM
GREAT PLAINS/AGRICULTURE
Resource-conserving agricultural production methods. Progress report August 1977-July 1978, 5:24301 (PB—301042)
GREENHOUSE EFFECT/POLITICAL ASPECTS
Toward a political analysis of the consequences of a world climate change produced by increasing atmospheric carbon dioxide, 5:24664 (CONF-800475—1)
GREENHOUSES/DESIGN
Self-contained solar greenhouse (Patent), 5:23893
GREENHOUSES/LATENT HEAT STORAGE
Solar greenhouse phase change storage, 5:23974
GREENHOUSES/SENSIBLE HEAT STORAGE
Solar greenhouse phase change storage, 5:23974
GREENHOUSES/TRICKLE-TYPE COLLECTORS
Self-contained solar greenhouse (Patent), 5:23893
GROUND MOTION/FORECASTING
Prediction of ground motion from underground nuclear weapons tests as it relates to siting of a nuclear waste storage facility at NTS and compatibility with the weapons test program, 5:23745 (SAND—80-1020/1)
Prediction of ground motion from underground nuclear weapons tests as it relates to siting of a nuclear waste storage facility at NTS and compatibility with the weapons test program, 5:23746 (SAND—80-1020/1)
GROUND SOURCE HEAT PUMPS
Feasibility study on a combined summer cooling and winter heating system, based on a combination of solar energy and ground heat pumps, 5:23883 (EUR—6701)
GROUND SOURCE HEAT PUMPS/RESEARCH PROGRAMS
Solar assisted heat pump program overview and summary of work at Brookhaven National Laboratory, 5:23875 (BNL—27662)
GROUND SUBSIDENCE/FORECASTING
Evaluation of European empirical methods for subsidence in US coal fields, 5:23538 (SAND—80-0537)
GROUND WATER/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
GROUND WATER/CHEMICAL ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
GROUND WATER/FLOW MODELS
Waste Isolation Safety Assessment Program. Technical progress report for FY-1978, 5:23737 (PNL—2874)
GROUND WATER/MONITORING
Disposal of high alkaline fly ash sludge in a decoaled mine seam, 5:23505 (METC/SP—79/10(Pt.2))
GROUND WATER WITHDRAWAL
See FLUID WITHDRAWAL
GROUND-WATER RESERVES
See AQUIFERS
GROUTING
Fly ash/cement grouts for mine backfilling, 5:23510 (METC/SP—79/10(Pt.2))
Use and potential for fly ash in grouting (Formulae and methods), 5:23509 (METC/SP—79/10(Pt.2))
GUAYULE/ENERGY SOURCES
Green factories, 5:23843
GULF COAST/GEOPRESSURED SYSTEMS
Environmental overview of geopressured-geothermal development: Texas Gulf Coast, 5:23995 (UCRL—15094)
GULF GENERAL ATOMIC FAST BREEDER REACTOR
See GCFR REACTOR
GULF OF ALASKA/ENERGY SOURCE DEVELOPMENT
Alaska OCS socioeconomic studies program. Technical report No. 36. Northern Gulf of Alaska petroleum development scenarios: sociocultural impacts, 5:23603 (PB—300699)
GYPSUM CEMENTS/ADDITIVES
Sulfate specifications as a constraint to gypsum addition to cement and possible replacement of gypsum as an additive. Phase I. Final quarterly technical progress report, December 1979-January-February 1980, 5:24292 (DOE/CS/40221—6)

H

HADRON-HADRON INTERACTIONS/PARTICLE PRODUCTION
Sources of prompt leptons in hadronic collisions, 5:24850
HADRONS
See also MESONS
HADRONS/PARTICLE PRODUCTION
Search for the production of a new quark flavor at the highest PETRA energies (33 to 35.8 GeV (c.m.)), 5:24835 (DOE/ER/03069—770)
HAFNIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
HAFNIUM/CATALYTIC EFFECTS
Catalyst for synthesis of methanol (Patent), 5:23774
HAFNIUM 174/ENERGY LEVELS
Angular momentum fluctuation energy in the cranking model, 5:24949
HALIDES
See also BROMIDES
CHLORIDES
HALIDES/CRYSTAL DOPING
Observation of resonantly enhanced degenerate four-wave mixing in doped alkali halides, 5:24475
HALIDES/OPTICAL PROPERTIES
Observation of resonantly enhanced degenerate four-wave mixing in doped alkali halides, 5:24475
HALL GENERATORS
See MHD GENERATORS
HANFORD RESERVATION/RADIOACTIVE WASTE MANAGEMENT
Sorption studies at Hanford for the control of radioactive wastes, 5:23740 (RHO-SA—155)
HASTELLOY X/CREEP
Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, October 1, 1979-December 31, 1979, 5:24049 (COO—2975-40)
HASTELLOY X/TENSILE PROPERTIES
Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, October 1, 1979-December 31, 1979, 5:24049 (COO—2975-40)
HAWAII/GEOTHERMAL RESOURCES
Operations research for geothermal development in California and Hawaii, 5:23981
HAWAII/POWER TRANSMISSION LINES
Study of the feasibility of linking the islands of Maui, Molokai, and Lanai with submarine electrical power cables, 5:24039 (HNEI—7902)
HAZARDS/EMERGENCY PLANS
Natural Hazards Observer, volume 2, number 4, June 1978, 5:25117 (PB—300976)
HAZARDS/PUBLIC OPINION
CANVEY: the reaction of a community exposed to substantial risks, 5:24662 (ALO—80)
HD 8077
See NICKEL BASE ALLOYS
HEALTH PHYSICS
See RADIATION PROTECTION
HEART/CALIBRATION STANDARDS
Analytical techniques for cell fractions. XXVII. Use of heart proteins as reference standards in two-dimensional electrophoresis, 5:24673
HEAT EXCHANGERS
See also HEAT PUMPS
HEAT EXCHANGERS/BIOLOGICAL FOULING
Performance improvement for ocean thermal energy conversion systems. Final report (Helical rotor inserts for preventing biofouling), 5:23869 (DSE—0034-T1)
HEAT EXCHANGERS/DESIGN
Advanced Coal-Fueled Combustor/Heat Exchanger Technology Study. Research and development plan, 5:24012 (FE—2612-16)
European contribution to heat exchanger design/performance: HTFS research and computer programs. Final report, 5:24510 (DOE/ET/12438—T1)
Innovative double walled heat exchanger for use in solar water heating, 5:23944
HEAT EXCHANGERS/FOULING
Operating experience on a 1,000-ton/day ammonia plant at Modderfontein, 5:23790
HEAT EXCHANGERS/MATERIALS
Development of nondestructive evaluation techniques for high-temperature ceramic heat exchanger components. Tenth quarterly report, January-March 1980, 5:24507 (ANL/MSD/FE—80-2)
HEAT EXCHANGERS/PERFORMANCE
European contribution to heat exchanger design/performance: HTFS research and computer programs. Final report, 5:24510 (DOE/ET/12438—T1)
HEAT EXCHANGERS/PERFORMANCE TESTING
Innovative double walled heat exchanger for use in solar water heating, 5:23944
HEAT EXCHANGERS/RELIABILITY
Large oxygen plant economics and reliability, 5:23786
HEAT PIPES/BIBLIOGRAPHIES
Heat pipe technology: a bibliography with abstracts. Quarterly update July-September 1979, 5:24512 (TAC-HP—79-003)
HEAT PIPES/MATERIALS
Ceramic heat pipe development. Quarterly report, January 1-March 31, 1980, 5:24511 (DOE/TIC—11192)
HEAT PIPES/RESEARCH PROGRAMS
Ceramic heat pipe development. Quarterly report, January 1-March 31, 1980, 5:24511 (DOE/TIC—11192)
HEAT PUMPS
See also CHEMICAL HEAT PUMPS
GROUND SOURCE HEAT PUMPS
SOLAR-ASSISTED HEAT PUMPS
HEAT PUMPS/ECONOMICS
Thermally driven open-cycle heat pump system, 5:24306 (CONF-800549—1)
HEAT PUMPS/ENERGY CONSERVATION
Thermally driven open-cycle heat pump system, 5:24306 (CONF-800549—1)
HEAT PUMPS/WASTE HEAT UTILIZATION
Thermally driven open-cycle heat pump system, 5:24306 (CONF-800549—1)
HEAT RECOVERY EQUIPMENT/ECONOMIC ANALYSIS
Potential industrial applications for fluidized-bed waste heat recovery systems, 5:24308 (DOE/CS/40255—1)
HEAT RECOVERY EQUIPMENT/HEAT PIPES
Ceramic heat pipe development. Quarterly report, January 1-March 31, 1980, 5:24511 (DOE/TIC—11192)
HEAT RECOVERY EQUIPMENT/TECHNOLOGY ASSESSMENT
Potential industrial applications for fluidized-bed waste heat recovery systems, 5:24308 (DOE/CS/40255—1)
HEAT STORAGE
See also LATENT HEAT STORAGE
HEAT STORAGE/MEETINGS
Thermal storage and heat transfer in solar energy systems, 5:23975
HEAT TRANSFER/MEETINGS
Thermal storage and heat transfer in solar energy systems, 5:23975
HEAT TRANSMISSION
See HEAT TRANSFER
HEATING SYSTEMS
See also GEOTHERMAL HEATING SYSTEMS
SOLAR HEATING SYSTEMS
HEATING SYSTEMS/COST
Optimization technique for minimizing the cost of self-powering industrial HVAC systems, 5:24304
HEATING SYSTEMS/ENERGY CONSERVATION
R and D activities in pulse combustion at BNL, 5:24248 (BNL—27602)
HEATING SYSTEMS/ENERGY CONSUMPTION
Residential energy consumption survey: characteristics of the housing stock and households, 5:24253 (DOE/EIA—0207/2)
HEAVY ION REACTIONS
See also ALUMINIUM 27 REACTIONS
ARGON 40 REACTIONS
BERYLLIUM 9 REACTIONS
CARBON 12 REACTIONS
CARBON 13 REACTIONS
CHLORINE 35 REACTIONS
LEAD 208 REACTIONS
LITHIUM 6 REACTIONS
NEON 20 REACTIONS
NITROGEN 15 REACTIONS
OXYGEN 16 REACTIONS
OXYGEN 18 REACTIONS
SULFUR 34 REACTIONS
HEAVY ION REACTIONS/COHERENT SCATTERING
Coherence angle in heavy-ion reactions, 5:24895
HEAVY ION REACTIONS/COUPLED CHANNEL THEORY
Techniques for heavy-ion coupled-channels calculations. I. Long-range Coulomb coupling, 5:24943
HEAVY ION REACTIONS/ELASTIC SCATTERING
Coherence angle in heavy-ion reactions, 5:24895
HEAVY ION REACTIONS/FUSION REACTIONS
Coherence angle in heavy-ion reactions, 5:24895
HEAVY ION REACTIONS/INELASTIC SCATTERING
Techniques for heavy-ion coupled-channels calculations. I. Long-range Coulomb coupling, 5:24943

Techniques for heavy-ion coupled-channels calculations. II. Iterative solution of the coupled radial equations, 5:24944
HEAVY IONS/COLLISIONS
X-ray emission in heavy-ion collisions. Progress report, April 1, 1979-March 31, 1980, 5:24805 (DOE/ER/06036—3)
HEAVY NUCLEI/FISSION BARRIER
Prediction of heavy element fission barrier features for multiple chance neutron cross-section calculations (Z = 76 to 100, N = 118 to 184), 5:24927 (UCRL—84370)
HEAVY NUCLEI/NEUTRON SEPARATION ENERGY
Prediction of heavy element fission barrier features for multiple chance neutron cross-section calculations (Z = 76 to 100, N = 118 to 184), 5:24927 (UCRL—84370)
HELIOS FACILITY/VACUUM SYSTEMS
Design and operational characteristics of the cryopump high-vacuum system for the 25 000-l target chamber of the Helios Laser Facility, 5:25096
HELIOSTATS/COST
Heliostat production evaluation and cost analysis, 5:23962 (SERI/TR—8052-1)
HELIOSTATS/PRODUCTION
Heliostat production evaluation and cost analysis, 5:23962 (SERI/TR—8052-1)
HELIUM/ION-ATOM COLLISIONS
Charge exchange measurements in helium using a double tandem accelerator-decelerator source of low energy highly stripped oxygen ions, 5:24826
HELIUM/MASS SPECTROSCOPY
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
HELIUM/RADIOSENSITIVITY EFFECTS
Does oxygen enhance the radiation: induced inactivation of penicillinase. Progress report, December 1, 1979-November 30, 1980, 5:24734 (DOE/EV/03221—62)
HELIUM 3/ELECTRONIC STRUCTURE
Band structure and thermodynamic properties of He atoms near a graphite surface, 5:24471
HELIUM 3 REACTIONS/STRIPPING
Description of direct nuclear rearrangement reactions using various coupled channel equations, 5:24946
HELIUM 3 REACTIONS/TWO-NUCLEON TRANSFER REACTIONS
(^{3}He, n) reaction on tellurium isotopes (25.4 MeV, angular distributions, zero-range DWBA, pairing model), 5:24918
HELIUM 3 TARGET/DEUTERON REACTIONS
Low-energy nuclear fusion data and their relation to magnetic and laser fusion, 5:24890 (LA—8087)
HELIUM 4/ELECTRONIC STRUCTURE
Band structure and thermodynamic properties of He atoms near a graphite surface, 5:24471
HELIUM 4 TARGET/LITHIUM 6 REACTIONS
Vector analyzing power in the elastic scattering of ^{6}Li(pol) by ^{4}He (15.1 to 22.7 MeV, L-S coupling), 5:24892
HELIUM IONS/COLLISIONS
Temperature dependence of the beam-foil interaction, 5:24811
HELIUM IONS/ENERGY-LEVEL TRANSITIONS
Temperature dependence of the beam-foil interaction, 5:24811
HEMATIN
See HEME
HEMATOPOIETIC SYSTEM/STEM CELLS
Haemopoietic stem cells: concepts and definitions, 5:24730
HEMATOPORPHYRIN (HEME)
See HEME
HEME/CHEMICAL RADIATION EFFECTS
Chain inequivalence in bovine methemoglobin. Progress report, December 1, 1979-November 30, 1980, 5:24733 (DOE/EV/03221—61)
HEMIC DISEASES
See also ANEMIAS
HEMIC DISEASES/DIAGNOSIS
Analysis of iron content in individual human red blood cells by electron microprobe and scanning electron microscope, 5:24719
HEMIN
See HEME
HEMORRHAGE/BIOLOGICAL EFFECTS
Modulation of erythropoietin concentrations by manipulation of hypercarbia, 5:24690
HEPARIN/BIOLOGICAL EFFECTS
Changes in plasma lipoprotein distribution and formation of two unusual particles after heparin-induced lipolysis in hypertriglyceridemic subjects, 5:24718
HEREDITY
See GENETICS
HETEROCYCLIC ACIDS/CRYSTAL STRUCTURE
Neutron diffraction study of quinolinic acid recrystallized from D_2O: evaluation of temperature and isotope effects in the structure, 5:24460
HEVEA/ENERGY SOURCES
Green factories, 5:23843
HHIRF
(Holifield Heavy Ion Research Facility.)
HHIRF/ACCELERATOR FACILITIES
UNISOR facility: recent developments and future directions, 5:24552 (CONF-790976—10)
HIGH BTU GAS/PRODUCTION
Production of SNG from shale oil by catalytic gasification in a steam-hydrogen atmosphere, 5:23629 (LETC/RI—79/11)
HIGH BTU GAS/YIELDS
Production of SNG from shale oil by catalytic gasification in a steam-hydrogen atmosphere, 5:23629 (LETC/RI—79/11)
HIGH EXPLOSIVES
See CHEMICAL EXPLOSIVES
HIGH-FREQUENCY HEATING
See also ECR HEATING
HIGH-FREQUENCY HEATING/REVIEWS
Rf heating of mirrors, 5:24982 (UCID—18623)
HIGH-FREQUENCY HEATING/VORTICES
Vortex formation during rf heating of plasma, 5:24980 (PPPL—1658)
HIGH-LEVEL RADIOACTIVE WASTES/CLASSIFICATION
Transuranic contaminated waste functional definition and implementation, 5:23751 (UCRL—15229)
HIGH-TEMPERATURE FUEL CELLS/ELECTROLYTES
Advanced fuel cell development. Progress report, July-September 1979 (Molten carbonate fuel cells), 5:24233 (ANL—79-110)
Advanced fuel cell development. Progress report, April-June 1979 (Molten carbonate fuel cells), 5:24232 (ANL—79-84)
HIGH-TEMPERATURE FUEL CELLS/RESEARCH PROGRAMS
Advanced fuel cell development. Progress report, July-September 1979 (Molten carbonate fuel cells), 5:24233 (ANL—79-110)
Advanced fuel cell development. Progress report, April-June 1979 (Molten carbonate fuel cells), 5:24232 (ANL—79-84)
HIGH-TEMPERATURE GAS-COOLED REACTOR
See HTGR TYPE REACTORS
HIGHWAYS
See ROADS
HOG FUEL
See WOOD WASTES
HOLIFIELD HEAVY ION RESEARCH FACILITY
See HHIRF
HOLMES-STRETFORD PROCESS/CHEMISTRY
Holmes-Stretford process for desulfurization of tail gases from acid-gas systems, 5:23415
HOLMES-STRETFORD PROCESS/FLOWSHEETS
Holmes-Stretford process for desulfurization of tail gases from acid-gas systems, 5:23415
HOLMIUM/COSTER-KRONIG TRANSITIONS
L/sub 2,3/-subshell x-ray fluorescence and Coster-Kronig yields at Z=64 and 67, 5:24815
HOMOGENEOUS PLASMA/DISTRIBUTION FUNCTIONS
Steady-state response of the electron distribution function to an applied electric field, 5:25020
HOSPITALS/ENERGY CONSUMPTION
Buildings energy use data book. Edition 2, 5:24244 (ORNL—5552)
HOT GAS CLEANUP/FEASIBILITY STUDIES
Glass-fly ash from a new hot gas clean-up process, 5:23413 (METC/SP—79/10(Pt.1))
HOT GAS CLEANUP/PERFORMANCE TESTING
Investigation of high velocity wedge separator for particle removal in coal gasification plants. Quarterly report, 5:23412 (FE—2709-T1)
HOT LABS
Radioactive Materials Analytical Laboratory, 5:24488 (CONF-791103—111)
HOT PLASMA/EMISSION SPECTRA
Multiple ionization and x-ray emission accompanying the cascade decay of inner-shell vacancies in Fe, 5:24828
HOT PLASMA/X-RAY SPECTRA
Multiple ionization and x-ray emission accompanying the cascade decay of inner-shell vacancies in Fe, 5:24828
HOT-DRY-ROCK SYSTEMS/MEASURING INSTRUMENTS
Borehole survey instrumentation development for geothermal applications, 5:23988 (LA-UR—80-670)
HOT-DRY-ROCK SYSTEMS/WELL LOGGING EQUIPMENT
Borehole survey instrumentation development for geothermal applications, 5:23988 (LA-UR—80-670)
HOUSES/ANNUAL CYCLE ENERGY SYSTEM
Research program on the economic feasibility and commercialization potential of the ACES system. Twenty-fourth periodic progress report, 5:24252 (DOE/CS/02130—T1)

HOUSES/BUILDING MATERIALS
Fly ash housing scheme: an experimental project in Neyveli, 5:23471 (METC/SP—79/10(Pt.1))
HOUSES/ENERGY CONSERVATION
Solar-assisted low energy dwellings, 5:23879 (DOE/CS—T0145)
HOUSES/FLYWHEEL ENERGY STORAGE
Low-cost flywheel demonstration program. Final report, 1 October 1977-31 December 1979, 5:24099 (CONS—5085-T2)
HOUSES/PASSIVE SOLAR HEATING SYSTEMS
Direct gainhome using concrete cored slab, 5:23903
HOUSES/SOLAR SPACE HEATING
Solar air systems for space heating, 5:23894
Solar-assisted low energy dwellings, 5:23879 (DOE/CS—T0145)
HOUSES/WEATHERIZATION
Weatherization training; a notebook for weatherization. Supplement Number 3: transportation, 5:24256 (PB—301143)
HTGR TYPE REACTORS/COATED FUEL PARTICLES
Dependence of silicon carbide coating properties on deposition parameters: preliminary report, 5:24050 (ORNL/TM—7209)
HUDSON RIVER/POWER PLANTS
Impact of impingement on the Hudson River white perch population, 5:24026 (CONF-800543—4)
HUMAN CELLS
See ANIMAL CELLS
HUMAN POPULATIONS
See also AMERICAN INDIANS
URBAN POPULATIONS
HUMAN POPULATIONS/DOSE COMMITMENTS
Reprocessing nuclear fuels of the future: a radiological assessment of advanced (Th,U) carbide fuel, 5:23704
HUMAN POPULATIONS/RADIATION DOSES
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)
HYBRID ELECTRIC-POWERED VEHICLES/ENERGY EFFICIENCY
Electric and Hybrid Vehicle System Research and Development Project: hybrid vehicle potential assessment. Volume V. Flywheel systems, 5:24349 (CONS—4209-T1(Vol.5))
HYBRID ELECTRIC-POWERED VEHICLES/FUEL CELLS
Fuel cells for electric utility and transportation applications, 5:24234 (BNL—27452)
HYBRID ELECTRIC-POWERED VEHICLES/FUEL ECONOMY
Electric and Hybrid Vehicle System Research and Development Project: hybrid vehicle potential assessment. Volume V. Flywheel systems, 5:24349 (CONS—4209-T1(Vol.5))
HYBRID ELECTRIC-POWERED VEHICLES/LIFE-CYCLE COST
Hybrid vehicle potential assessment. Volume 10. Electric and hybrid vehicle cost handbook, 5:24342 (CONS—4209-T1(Vol.10))
HYBRID ELECTRIC-POWERED VEHICLES/OPERATING COST
Hybrid vehicle potential assessment. Volume 10. Electric and hybrid vehicle cost handbook, 5:24342 (CONS—4209-T1(Vol.10))
HYBRID ELECTRIC-POWERED VEHICLES/PERFORMANCE TESTING
Energy storage propulsion system for rapid transit cars. Test results and system evaluation. Final report, 5:24347 (PB—300918)
HYBRID ELECTRIC-POWERED VEHICLES/RESEARCH PROGRAMS
Electric and Hybrid Vehicle System Research and Development Project: hybrid vehicle potential assessment. Volume V. Flywheel systems, 5:24349 (CONS—4209-T1(Vol.5))
HYBRID REACTORS/BREEDING BLANKETS
Production of substitute natural gas by a fusion hybrid reactor coupled to a catalyzed coal gasification plant. Final report, 1 May 1979-1 October 1979, 5:23766 (UWFPP—6)
HYBRID REACTORS/CRITICALITY
Accidental criticality of a fusion-fission hybrid blanket design, 5:25070
HYBRID REACTORS/ECONOMICS
Tandem mirror fusion fission hybrid studies, 5:25064 (UCRL—84018)
HYBRID REACTORS/SYNTHETIC FUELS
Production of substitute natural gas by a fusion hybrid reactor coupled to a catalyzed coal gasification plant. Final report, 1 May 1979-1 October 1979, 5:23766 (UWFPP—6)
HYDROCARBONS
See also AZULENE
BENZOPYRENE
POLYCYCLIC AROMATIC HYDROCARBONS
PYRENE
Effect of container preparation on the growth of protium and methane impurities into tritium gas, 5:25095
HYDROCARBONS/AIR POLLUTION CONTROL
Durability testing at 5 atmospheres of advanced catalysts and catalyst supports for gas turbine engine combustors, 5:24338 (DOE/NASA/9416—80/2)
HYDROCARBONS/CATALYTIC CRACKING
Process for regenerating metal-contaminated hydrocarbon conversion catalysts (Patent), 5:23590
HYDROCARBONS/DENITRIFICATION
Hydroprocessing of hydrocarbons over nickel, moly, platinum catalyst (Patent), 5:23593
HYDROCARBONS/DESULFURIZATION
Hydroprocessing of hydrocarbons over nickel, moly, platinum catalyst (Patent), 5:23593
HYDROCARBONS/HYDROCRACKING
Hydroprocessing of hydrocarbons over nickel, moly, platinum catalyst (Patent), 5:23593
HYDROCARBONS/HYDROGENATION
Hydroprocessing of hydrocarbons over nickel, moly, platinum catalyst (Patent), 5:23593
HYDROCARBONS/MONITORING
Diesel hydrocarbon measurement - series filter test. Technical report, 5:24356 (PB—301410)
HYDROCARBONS/OXIDATION
Removal of tritium and tritium-containing compounds from a gaseous stream (Patent), 5:23764
HYDROCARBONS/PARTIAL OXIDATION PROCESSES
Partial oxidation process (Patent), 5:23772
HYDROCARBONS/STEAM REFORMER PROCESSES
Process for alternately steam reforming sulfur containing hydrocarbons that vary in oxygen content (Patent), 5:23610
HYDROCARBONS/SYNTHESIS
Applied research and evaluation of process concepts for liquefaction and gasification of western coals, 5:23444 (FE—2006-17)
HYDROCYCLONES
See CYCLONE SEPARATORS
HYDROGEN/ABSORPTION
HVEM in situ hydriding of hydrogen storage materials, 5:24394 (CONF-791132—5)
HYDROGEN/CHEMICAL BONDS
Photoemission studies of hydrogen chemisorption on Nb, 5:24399
HYDROGEN/CHEMISORPTION
Kinetics of two-state chemisorption: Hydrogen on niobium, 5:24400
Photoemission studies of hydrogen chemisorption on Nb, 5:24399
HYDROGEN/DIFFUSION
Effect of container preparation on the growth of protium and methane impurities into tritium gas, 5:25095
Reaction of hydrogen with hydroxyl-free vitreous silica, 5:24469
HYDROGEN/ENERGY LEVELS
Photoemission studies of hydrogen chemisorption on Nb, 5:24399
HYDROGEN/FLAMES
Multiplicity and stability of nonadiabatic hydrogen-oxygen-nitrogen flames, 5:23770
HYDROGEN/FORM FACTORS
Integrals of the squared atomic form factor over the momentum transfer, 5:24821
HYDROGEN/IMPURITIES
Effect of container preparation on the growth of protium and methane impurities into tritium gas, 5:25095
HYDROGEN/ION-ATOM COLLISIONS
Differential charge transfer to the continuum by ions in atomic hydrogen. Progress report and renewal proposal, 5:24819 (DOE/ER/10512—T1)
Electron-capture collisions at keV energies of boron and other multiply charged ions with atoms and molecules. II. Atomic hydrogen, 5:24824
HYDROGEN/ION-MOLECULE COLLISIONS
Differential charge transfer to the continuum by ions in atomic hydrogen. Progress report and renewal proposal, 5:24819 (DOE/ER/10512—T1)
HYDROGEN/KAONIC ATOMS
X-ray yields in protonium and mesic hydrogen, 5:24818
HYDROGEN/METALLURGICAL EFFECTS
Hydrogen attack of HSLA steels, 5:24390
Hydrogen absorption in metals: a field ion microscopy study. Progress report, June 1, 1979-May 31, 1980, 5:24386 (DOE/ER/10430—1)
HYDROGEN/MUONIC ATOMS
X-ray yields in protonium and mesic hydrogen, 5:24818
HYDROGEN/PHOTOELECTRON SPECTROSCOPY
Photoemission studies of hydrogen chemisorption on Nb, 5:24399
HYDROGEN/PHOTOIONIZATION
Complex-basis-function calculations of resolvent matrix elements: Molecular photoionization, 5:24829
HYDROGEN/PIONIC ATOMS
X-ray yields in protonium and mesic hydrogen, 5:24818

HYDROGEN/RADIOSENSITIVITY EFFECTS
Does oxygen enhance the radiation: induced inactivation of penicillinase. Progress report, December 1, 1979-November 30, 1980, 5:24734 (DOE/EV/03221—62)
HYDROGEN/RECOVERY
Process for hydrogen recovery from ammonia purge gases (Patent), 5:23777
HYDROGEN/REDUCING AGENTS
Thermodynamics of the tantalum-carbon-chlorine-hydrogen system applied to the CVD of carbide/carbon composite materials, 5:24395 (LA-UR—80-1252)
HYDROGEN/SEPARATION PROCESSES
Effect of the degree of hydration of the adsorbent on the chromatographic analysis of common gases, 5:24493 (DP-TR—9)
HYDROGEN/SOLUBILITY
Effect of container preparation on the growth of protium and methane impurities into tritium gas, 5:25095
HYDROGEN 2
See DEUTERIUM
HYDROGEN 3
See TRITIUM
HYDROGEN COMPOUNDS/LATENT HEAT STORAGE
Heat transfer and calorimetric studies of a direct contact-latent heat energy storage system (Disodium hydrogen phosphate), 5:23977
HYDROGEN DEUTERIDE/ISOTOPIC EXCHANGE
Molecular hydrogen exchange: A study of HD(v=5)+HD(v=0)→H_2+D_2, 5:24496
HYDROGEN FUEL CELLS/PERFORMANCE
Assessment of the air breathing, hydrogen fueled SPE fuel cell, 5:24237
Assessment of the solid polymer electrolyte fuel cell for mobile power plants, 5:24238
HYDROGEN FUEL CELLS/SOLID ELECTROLYTES
Assessment of the air breathing, hydrogen fueled SPE fuel cell, 5:24237
Assessment of the solid polymer electrolyte fuel cell for mobile power plants, 5:24238
HYDROGEN FUELS/COMBUSTION
Hydrogen engine performance analysis project. Second annual report, 5:24357 (SAN—1212-T1)
HYDROGEN IONS 1 PLUS/COLLISIONS
Measurement of the n = 2 density operator for hydrogen atoms produced by passing protons through thin carbon targets, 5:24810
HYDROGEN IONS 1 PLUS/ION-ATOM COLLISIONS
Differential charge transfer to the continuum by ions in atomic hydrogen. Progress report and renewal proposal, 5:24819 (DOE/ER/10512—T1)
HYDROGEN PRODUCTION
See also THERMOCHEMICAL PROCESSES
HYDROGEN PRODUCTION/THERMOCHEMICAL PROCESSES
Thermochemical cycles for the production of hydrogen (Patent), 5:23768
Thermochemical cyclic system for splitting water and/or carbon dioxide by means of cerium compounds and reactions useful therein (Patent), 5:23769
HYDROGEN SULFATES
See SULFURIC ACID
HYDROGEN SULFIDES/CORROSIVE EFFECTS
Silicon-nitride and metal composite (Patent), 5:24427
HYDROGEN SULFIDES/PRODUCTION
Preparation of hydrosulfides (Patent), 5:24456
HYDROGEN SULFIDES/REMOVAL
Process for purifying geothermal steam (Patent), 5:23992
State-of-the-art hydrogen sulfide control for geothermal energy systems: 1979, 5:23993 (DOE/EV—0068)
HYDROLASES/BIOLOGICAL RADIATION EFFECTS
Does oxygen enhance the radiation: induced inactivation of penicillinase. Progress report, December 1, 1979-November 30, 1980, 5:24734 (DOE/EV/03221—62)
HYDROLYSIS/CATALYSTS
Carbon monoxide shift catalysts and carbonyl sulfide hydrolysis catalysts, 5:23435
HYDROTHERMAL SYSTEMS/DRAWDOWN
Impacts of deep geothermal fluid production on shallow groundwater systems, 5:23983 (CONF-7910155—1)
HYDROTHERMAL SYSTEMS/FLUID WITHDRAWAL
Impacts of deep geothermal fluid production on shallow groundwater systems, 5:23983 (CONF-7910155—1)
HYDROTHERMAL SYSTEMS/HYDROLOGY
Impacts of deep geothermal fluid production on shallow groundwater systems, 5:23983 (CONF-7910155—1)
HYDROTHERMAL SYSTEMS/RESOURCE DEVELOPMENT
Land use siting considerations for hydrothermal energy facilities, 5:23989 (CONF-800517—4)
HYDROXY COMPOUNDS
(For organic compounds only and excluding SACCHARIDES, GLYCOSIDES and HYDROXY ACIDS.)
See also PHENOLS
HYDROXY COMPOUNDS/CHEMICAL RADIATION EFFECTS
process for coating a substrate with a radiation and moisture curable coating composition (Patent), 5:24503
HYDROXYBENZENE
See PHENOL
HYDROXYL RADICALS/BIOCHEMICAL REACTION KINETICS
Favism inducing agents: a pulse radiolysis study of isouramil and convicine, 5:24735 (DOE/EV/03221—63)
HYDROXYL RADICALS/RADIOSENSITIVITY EFFECTS
Does oxygen enhance the radiation: induced inactivation of penicillinase. Progress report, December 1, 1979-November 30, 1980, 5:24734 (DOE/EV/03221—62)
HYDROXYLASE/BIOCHEMICAL REACTION KINETICS
Regulation of vitamin D metabolism in the kidney, 5:24694
HYDROXYTOLUENES
See CRESOLS
HYPERFRAGMENTS
See HYPERNUCLEI
HYPERNUCLEI/LEVEL WIDTHS
Widths of Σ-hypernuclear states, 5:24872
HYPOXIA
See ANOXIA

I

I-BEAM TYPE REACTORS/ACCELERATOR FACILITIES
Hearthfire reference concept No. 3. A rapid cycling synchrotron system, 5:24551 (ACC—6)
I-BEAM TYPE REACTORS/HEAVY ION REACTIONS
Hearthfire reference concept No. 3. A rapid cycling synchrotron system, 5:24551 (ACC—6)
I-BEAM TYPE REACTORS/REVIEWS
Intense pulsed ion beams for fusion applications, 5:25075 (SAND—80-0402)
IDAHO
See also RAFT RIVER VALLEY
IDAHO/MAGNETIC SURVEYS
Aerial radiometric and magnetic survey: Jordan Valley National Topographic Map, Idaho and Oregon. Rocky Mountain, 1979, 5:23685 (GJBX—95(80))
IDAHO/RADIOMETRIC SURVEYS
Aerial radiometric and magnetic survey: Jordan Valley National Topographic Map, Idaho and Oregon. Rocky Mountain, 1979, 5:23685 (GJBX—95(80))
ILLITE/STRAIN RATE
A study of the permanent effects of elevated temperature on the hydraulic properties of clay. Master's thesis, 5:24463 (PB—300686)
IMAGE PROCESSING/ALGORITHMS
Overview of image reconstruction, 5:25105 (BNL—27665)
IMAGE PROCESSING/LIGHTING SYSTEMS
Novel photographic method of recording images from cellulose nitrate film, 5:24579
IMAGE PROCESSING/REVIEWS
Overview of image reconstruction, 5:25105 (BNL—27665)
IMAGES/SPATIAL DISTRIBUTION
Overlapping pulse technique for imaging space-time-density contours in a gas, 5:24295
IMMUNE REACTIONS/INHIBITION
Inhibition of cytotoxic T lymphocytes with concanavalin A, 5:24703
IMPACT FUSION/FEASIBILITY STUDIES
Evaluation of impact fusion concepts. Final report, 1 June 1979-1 December 1979, 5:25078 (UWFPP—7)
IMPACT FUSION/RESEARCH PROGRAMS
Evaluation of impact fusion concepts. Final report, 1 June 1979-1 December 1979, 5:25078 (UWFPP—7)
IMPERIAL VALLEY/ENVIRONMENTAL IMPACTS
Geothermal environmental impact assessment: subsurface environmental assessment for four geothermal systems, 5:23994 (PB—300851)
IMPERIAL VALLEY/GEOTHERMAL RESOURCES
Operations research for geothermal development in California and Hawaii, 5:23981
IMPERIAL VALLEY/RESOURCE DEVELOPMENT
Geothermal environmental impact assessment: subsurface environmental assessment for four geothermal systems, 5:23994 (PB—300851)

IMPERMEABLE DRY ROCK
See HOT-DRY-ROCK SYSTEMS
IMPINGEMENT/ENVIRONMENTAL IMPACTS
Best approach to impact assessment is to use empirically based or simulation models to forecast impacts. Environmental Sciences Division Publication No. 1538 (Concerning the impact at power plants on fish populations), 5:24024 (CONF-800543—2)
Impact of impingement on the Hudson River white perch population, 5:24026 (CONF-800543—4)
Population-level assessments should be emphasized over community/ecosystem-level assessments. Environmental Sciences Division Publication No. 1535, 5:24025 (CONF-800543—3)
IMPURITIES/FAR ULTRAVIOLET RADIATION
Vacuum ultraviolet spectroscopic study of plasma impurities in the Tokapole II poloidal, 5:25001
INCLUSIONS/MATHEMATICAL MODELS
Thermal gradient brine inclusion migration in salt study: gas-liquid inclusions, preliminary model, 5:23732 (ONWI—85)
INCLUSIONS/TEMPERATURE GRADIENTS
Thermal gradient brine inclusion migration in salt study: gas-liquid inclusions, preliminary model, 5:23732 (ONWI—85)
INCOLOY 800/CREEP
Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, October 1, 1979-December 31, 1979, 5:24049 (COO—2975-40)
INCOLOY 800/TENSILE PROPERTIES
Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, October 1, 1979-December 31, 1979, 5:24049 (COO—2975-40)
INCONEL 600/PHYSICAL RADIATION EFFECTS
Experimental observations of effects of inert gas on cavity formation during irradiation, 5:24423 (ORNL/TM—7193)
INCONEL 617/CREEP
Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, October 1, 1979-December 31, 1979, 5:24049 (COO—2975-40)
INCONEL 617/TENSILE PROPERTIES
Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, October 1, 1979-December 31, 1979, 5:24049 (COO—2975-40)
INDIA/AGRICULTURE
Status of the fertilizer industry in India, 5:23789
INDIA/COMMERCIAL SECTOR
Energy demand and interfuel substitution in India (Use of translog price possibility frontier), 5:24198
INDIAN POINT-2 REACTOR/STEAM GENERATORS
PWR steam generator chemical cleaning. Phase II. Final report, 5:24046 (COO—4325-02)
INDIANA/HYDROLOGY
Effects of seepage from fly-ash settling ponds and construction dewatering on ground-water levels in the Cowles Unit, Indiana Dunes National Lakeshore, Indiana. Water-resources investigations (final) 1976-77, 5:24660 (PB—300843)
INDIANS (AMERICAN)
See AMERICAN INDIANS
INDIUM OXIDES/SPUTTERING
Sputtered indium-tin oxide/cadmium telluride junctions and cadmium telluride surfaces, 5:23824
Sputtered oxide/indium phosphide junctions and indium phosphide surfaces, 5:24294
INDIUM PHOSPHIDE SOLAR CELLS/FABRICATION
Sputtered oxide/indium phosphide junctions and indium phosphide surfaces, 5:24294
Thin films of InP for photovoltaic energy conversion. Second quarterly technical progress report, September 29, 1979-December 28, 1979, 5:23804 (COO—3004-2)
INDIUM PHOSPHIDES/CHEMICAL VAPOR DEPOSITION
Thin films of InP for photovoltaic energy conversion. Second quarterly technical progress report, September 29, 1979-December 28, 1979, 5:23804 (COO—3004-2)
INDIUM PHOSPHIDES/MICROSTRUCTURE
Thin films of InP for photovoltaic energy conversion. Second quarterly technical progress report, September 29, 1979-December 28, 1979, 5:23804 (COO—3004-2)
INDONESIA/ENERGY MANAGEMENT
Role of energy in the Indonesian economy, 1975 to 2000, 5:24206 (PB—301135)
INDOOR AIR POLLUTION/MEASURING METHODS
Formaldehyde monitoring program: development of sampling and analysis procedures. Report to the Consumer Product Sampling Commission, 5:24592 (DOE/TIC—11203)
INDUSTRIAL LAUNDRIES
See LAUNDRIES
INDUSTRIAL PLANTS
See also COAL GASIFICATION PLANTS
COAL LIQUEFACTION PLANTS
COAL PREPARATION PLANTS
FEED MATERIALS PLANTS
FOUNDRIES
OIL SHALE PROCESSING PLANTS
INDUSTRIAL PLANTS/CO-GENERATION
Price incentives of industrial cogeneration, 5:24305 (CONF-800548—1)
INDUSTRIAL PLANTS/COOLING SYSTEMS
Optimization technique for minimizing the cost of self-powering industrial HVAC systems, 5:24304
INDUSTRIAL PLANTS/DRYERS
Demonstration of energy conservation for multi-deck board dryers. Phase I. Final report, 5:24307 (DOE/CS/40167—T1)
INDUSTRIAL PLANTS/ELECTRIC POWER
Multifrequency factory operations. Final report, 5:24303 (SAN—1731-T3)
INDUSTRIAL PLANTS/ENERGY CONSERVATION
Energy conservation in industry; the present approach, the future opportunities. Final report, 5:24302 (PB—301244)
Multifrequency factory operations. Final report, 5:24303 (SAN—1731-T3)
INDUSTRIAL PLANTS/FUEL SUBSTITUTION
Powerplant and Industrial Fuel Use Act: annual report, 5:24203 (DOE/RG—0028)
INDUSTRIAL PLANTS/HEAT RECOVERY EQUIPMENT
Ceramic heat pipe development. Quarterly report, January 1-March 31, 1980, 5:24511 (DOE/TIC—11192)
INDUSTRIAL PLANTS/HEATING SYSTEMS
Optimization technique for minimizing the cost of self-powering industrial HVAC systems, 5:24304
INDUSTRIAL PLANTS/POWER DEMAND
Multifrequency factory operations. Final report, 5:24303 (SAN—1731-T3)
INDUSTRIAL PLANTS/SOLAR PROCESS HEAT
Solar production of industrial process steam, 5:23926 (SERI/TP—333-429)
INDUSTRIAL PLANTS/VENTILATION SYSTEMS
Optimization technique for minimizing the cost of self-powering industrial HVAC systems, 5:24304
INDUSTRIAL PLANTS/WASTE HEAT UTILIZATION
Demonstration of energy conservation for multi-deck board dryers. Phase I. Final report, 5:24307 (DOE/CS/40167—T1)
INDUSTRIAL SECTOR
See INDUSTRY
INDUSTRIAL WASTES/RECOMMENDATIONS
Epa chemical activities status report, first edition, 5:24621 (PB—301366)
INDUSTRIAL WASTES/RECYCLING
Environmental and resource conservation considerations of steel industry solid waste. Final report May 1978-February 1979, 5:24315 (PB—299919)
INDUSTRIAL WASTES/WASTE DISPOSAL
Environmental and resource conservation considerations of steel industry solid waste. Final report May 1978-February 1979, 5:24315 (PB—299919)
INDUSTRY
See also AEROSPACE INDUSTRY
CEMENT INDUSTRY
CHEMICAL INDUSTRY
COAL INDUSTRY
ELECTRIC POWER INDUSTRY
FOOD INDUSTRY
METAL INDUSTRY
NATURAL GAS INDUSTRY
NUCLEAR INDUSTRY
OIL SHALE INDUSTRY
PAPER INDUSTRY
PETROLEUM INDUSTRY
PLASTICS INDUSTRY
SOLAR INDUSTRY
TEXTILE INDUSTRY
INDUSTRY/ENERGY CONSERVATION
Energy conservation in industry; the present approach, the future opportunities. Final report, 5:24302 (PB—301244)
INDUSTRY/SOLAR PROCESS HEAT
Gas Research Institute's solar-augmented applications in industry program, 5:23913 (SERI/TP—333-429)
IPS system configurations, 5:23939 (SERI/TP—333-429)
New DOE-funded projects, 5:23908 (SERI/TP—333-429)
Seven DOE intermediate temperature (350°F to 550°F) steam demonstration projects, 5:23907 (SERI/TP—333-429)
Solar industrial process heat conference proceedings, 5:23905 (SERI/TP—333-429)
Solar industrial process hot water for cement block manufacture, 5:23919 (SERI/TP—333-429)
INERTIAL CONFINEMENT/COMPUTER CODES
SYSLOG: an accounting and performance measurement system for RSX11M V3.2, 5:25073 (KMSF-U—970)

INFORMATION CENTERS
ENSDF: its structure, contents, and use in applied research, 5:24886 (CONF-791243—1)
INHIBITORS (ENZYME)
See ENZYME INHIBITORS
IN-SITU GASIFICATION/ELECTROMAGNETIC SURVEYS
Cross-borehole electromagnetic probing to locate high-constrast anomalies, 5:24787
IN-SITU RETORTING/BIOLOGICAL EFFECTS
Phytotoxicity and plant response to aqueous effluents derived from an in situ oil shale process water (Effects of Omega-9 water on sced germination and growth), 5:23664
Toxicological evaluation of an in situ oil shale process water, 5:23648
IN-SITU RETORTING/ENVIRONMENTAL IMPACTS
Environmental research on a modified in situ oil shale task process. Progress report, 5:23660 (DOE/EV—0078)
Environmental research for in situ oil shale processing, 5:23667
IN-SITU RETORTING/LIQUID WASTES
Microbial interactions with aqueous effluents derived from in situ fossil fuel processing, 5:23663
Toxicological evaluation of an in situ oil shale process water, 5:23648
IN-SITU RETORTING/PERFORMANCE
Evaluation of retort performance from gas data, 5:23633
IN-SITU RETORTING/RESEARCH PROGRAMS
Investigation of the Geokinetics horizontal in situ oil shale retorting process. Quarterly report, January-March 1980, 5:23625 (DOE/LETC/10787—44)
INSOLATION/DATA
Environmental data for sites in the National Solar Data Network, 5:23797 (SOLAR/0010—80/04)
INSULATION (THERMAL)
See THERMAL INSULATION
INSULIN/BIOLOGICAL EFFECTS
Rapid ATP assays in perfused mouse liver by ^{31}P NMR, 5:24697
INTEGRAL DOSES/COMPUTER CODES
PABLM: a computer program to calculate accumulated radiation doses from radionuclides in the environment, 5:24754 (PNL—3209)
INTEGRATED UTILITY SYSTEMS
See TOTAL ENERGY SYSTEMS
INTERCHANGE INSTABILITY
See FLUTE INSTABILITY
INTERCONNECTED POWER SYSTEMS/REGULATIONS
Analysis of PURPA and solar energy, 5:23799 (SERI/TR—434-484)
INTERMEDIATE BTU GAS/CHEMICAL COMPOSITION
Formation and control of fuel-nitrogen pollutants in catalytic combustion of coal-derived gases. Quarterly technical progress report, December 15, 1978-March 15, 1979, 5:23426 (FE—2762-7)
INTERMEDIATE BTU GAS/COMBUSTION
Formation and control of fuel-nitrogen pollutants in catalytic combustion of coal-derived gases. Quarterly technical progress report, December 15, 1978-March 15, 1979, 5:23426 (FE—2762-7)
INTERMEDIATES (REACTION)
See REACTION INTERMEDIATES
INTERNAL COMBUSTION ENGINES
See also DIESEL ENGINES
GAS TURBINE ENGINES
INTERNAL COMBUSTION ENGINES/ECONOMIC ANALYSIS
Study of hydrogen-powered versus battery-powered automobiles, 5:24341 (ATR—79(7759)-(Vol.2))
INTERNAL COMBUSTION ENGINES/EXHAUST GASES
Hydrogen engine performance analysis project. Second annual report, 5:24357 (SAN—1212-T1)
INTERNAL COMBUSTION ENGINES/HYDROGEN FUELS
Hydrogen engine performance analysis project. Second annual report, 5:24357 (SAN—1212-T1)
Study of hydrogen-powered versus battery-powered automobiles, 5:24341 (ATR—79(7759)-(Vol.2))
Study of hydrogen-powered versus battery-powered automobiles, 5:24340 (ATR—79(7759)-1(Vol.3))
INTERNAL COMBUSTION ENGINES/PERFORMANCE TESTING
Hydrogen engine performance analysis project. Second annual report, 5:24357 (SAN—1212-T1)
INTERNAL COMBUSTION ENGINES/TECHNOLOGY ASSESSMENT
Study of hydrogen-powered versus battery-powered automobiles, 5:24341 (ATR—79(7759)-(Vol.2))
Study of hydrogen-powered versus battery-powered automobiles, 5:24340 (ATR—79(7759)-1(Vol.3))
INTERNAL CONTAMINATION
See RADIONUCLIDE KINETICS
INTERNAL IRRADIATION/INTEGRAL DOSES
PABLM: a computer program to calculate accumulated radiation doses from radionuclides in the environment, 5:24754 (PNL—3209)
INTERPOLATION/ALGORITHMS
Improved monotone piecewise cubic interpolation algorithm, 5:25113 (UCID—18620)
INVERTERS/RESEARCH PROGRAMS
Power conditioners and fuel cell inverters, 5:24242
IODINE 129/RADIATION DOSES
Iodine-129 dose to the world population from the nuclear power industry, 5:24628 (CONF-791103—107)
ION ACOUSTIC WAVES/REVIEWS
Critical survey of ion-acoustic waves (Book), 5:25036
ION BEAM TYPE REACTORS
See I-BEAM TYPE REACTORS
ION BEAMS/ACCELERATION
Production and postacceleration of intense ion beams in magnetically insulated gaps, 5:24550
ION BEAMS/COMPRESSION
Propagation of intense ion beams in straight and tapered z-discharge plasma channels, 5:25081
ION BEAMS/ORBITS
Propagation of intense ion beams in straight and tapered z-discharge plasma channels, 5:25081
ION COLLISIONS
See also ELECTRON-ION COLLISIONS
ION-ATOM COLLISIONS
ION COLLISIONS/ELECTRON TRANSFER
Measurement of the n = 2 density operator for hydrogen atoms produced by passing protons through thin carbon targets, 5:24810
ION COLLISIONS/ENERGY-LEVEL TRANSITIONS
Temperature dependence of the beam-foil interaction, 5:24811
ION COLLISIONS/TRANSMISSION
Measurement of the n = 2 density operator for hydrogen atoms produced by passing protons through thin carbon targets, 5:24810
ION COLLISIONS/X RADIATION
X-ray emission in heavy-ion collisions. Progress report, April 1, 1979-March 31, 1980, 5:24805 (DOE/ER/06036—3)
ION MICROSCOPY/ULTRALOW TEMPERATURE
Properties and applications of ion-implanted alloys, 5:24410
ION SOURCES
See also PENNING ION SOURCES
ION SOURCES/PERFORMANCE TESTING
Development of the ion source for PDX neutral beam injection, 5:25063 (CONF-791102—161)
ION SOURCES/REVIEWS
Intense pulsed ion beams for fusion applications, 5:25075 (SAND—80-0402)
ION WAVE INSTABILITY/CHARGE DISTRIBUTION
Ion-acoustic double layers, 5:25032
ION WAVE INSTABILITY/PLASMA SIMULATION
Ion-acoustic double layers, 5:25032
ION-ATOM COLLISIONS/EXCITATION
Experimental confirmation of a scaling law for the $1s\sigma$ excitation probability for $Z_1+Z_2>120$, and its breakdown in Pb+Cm collisions at very small internuclear distances, 5:24827
IONIC CRYSTALS/SCHOTTKY DEFECTS
Elastic relaxation associated with the formation and motion of Schottky defects in ionic crystals, 5:24459
IONOPHORESIS
See ELECTROPHORESIS
IONOSPHERE/DRIFT INSTABILITY
Prompt striations in ionospheric barium clouds due to a velocity space instability, 5:24802
IONOSPHERE/INSTABILITY GROWTH RATES
Prompt striations in ionospheric barium clouds due to a velocity space instability, 5:24802
IOWA/DEGREE DAYS
Passive design tutorial, 5:23899
IOWA/INSOLATION
Passive design tutorial, 5:23899
IOWA/SOLAR ENERGY
Iowa solar applications: holding at the do-it-yourself level, 5:23873
IOWA/WIND POWER
Iowa solar applications: holding at the do-it-yourself level, 5:23873
IRON/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
IRON/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))

IRON/EMISSION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
IRON/MATERIALS RECOVERY
Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation. Volume II. working papers, 5:24329 (PB—300848)
Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation, 5:24330 (PB—300849)
IRON/PION MINUS REACTIONS
Products of stopped-pion interactions with Cu and Ta, 5:24914
IRON/PION PLUS REACTIONS
Products of stopped-pion interactions with Cu and Ta, 5:24914
IRON/QUANTITATIVE CHEMICAL ANALYSIS
Analysis of iron content in individual human red blood cells by electron microprobe and scanning electron microscope, 5:24719
IRON/X-RAY SPECTRA
Multiple ionization and x-ray emission accompanying the cascade decay of inner-shell vacancies in Fe, 5:24828
IRON 54/ENERGY LEVELS
800-MeV inelastic proton scattering from ^{40}Ca, ^{48}Ca, and ^{54}Fe, 5:24911
IRON 54 TARGET/PROTON REACTIONS
800-MeV inelastic proton scattering from ^{40}Ca, ^{48}Ca, and ^{54}Fe, 5:24911
IRON ALLOYS
See also IRON BASE ALLOYS
IRON ALLOYS/CASTING
Fe-based long range ordered alloys (Patent), 5:24363
IRON ALLOYS/CHEMISTRY
Sulfur and oxygen chemistry at free surfaces and grain boundaries of iron alloys, 5:24407
IRON ALLOYS/CORROSION
Nickel-iron alloy corrosion in a sealed pyrotechnic system, 5:24413 (MLM—2707(OP))
IRON ALLOYS/GRAIN BOUNDARIES
Sulfur and oxygen chemistry at free surfaces and grain boundaries of iron alloys, 5:24407
IRON ALLOYS/MAGNETIC PROPERTIES
Microstructure and magnetic properties of Fe-Cr-Co alloys, 5:24373
IRON ALLOYS/MICROSTRUCTURE
Comparative analysis of the cellular and Johnson-Mehl microstructures through computer simulation, 5:24376
Microstructure and magnetic properties of Fe-Cr-Co alloys, 5:24373
IRON ALLOYS/ORDER PARAMETERS
Fe-based long range ordered alloys (Patent), 5:24363
IRON ALLOYS/PHYSICAL RADIATION EFFECTS
Relationship between swelling and the shear modulus of irradiated metal, 5:24421 (HEDL-SA—1774-FP)
IRON ALLOYS/SEGREGATION
Sulfur and oxygen chemistry at free surfaces and grain boundaries of iron alloys, 5:24407
IRON ALLOYS/SWELLING
Relationship between swelling and the shear modulus of irradiated metal, 5:24421 (HEDL-SA—1774-FP)
IRON BASE ALLOYS
See also STEELS
IRON BASE ALLOYS/CRACKS
Hydrogen absorption in metals: a field ion microscopy study. Progress report, June 1, 1979-May 31, 1980, 5:24386 (DOE/ER/10430—1)
IRON BASE ALLOYS/EXPANSION
Hydrogen attack of HSLA steels, 5:24390
IRON BASE ALLOYS/FRACTURE PROPERTIES
Structure-property relations and the design of Fe-4Cr-C base structural steels for high strength and toughness, 5:24378
IRON BASE ALLOYS/GAS METAL-ARC WELDING
Weldability of thermally grain-refined Fe-12Ni-0.25Ti for cryogenic structural applications, 5:24369 (LBL—10259)
IRON BASE ALLOYS/MICROSTRUCTURE
Structure-property relations and the design of Fe-4Cr-C base structural steels for high strength and toughness, 5:24378
IRON BASE ALLOYS/PHYSICAL RADIATION EFFECTS
Swelling and phase instability in neutron irradiated compositional variants of alloy D9, 5:24420 (DOE/TIC—11202)
IRON BASE ALLOYS/SAMPLE PREPARATION
Hydrogen absorption in metals: a field ion microscopy study. Progress report, June 1, 1979-May 31, 1980, 5:24386 (DOE/ER/10430—1)
IRON BASE ALLOYS/WELDED JOINTS
Delta ferrite-containing austenitic stainless steel resistant to the formation of undesirable phases upon aging (Patent), 5:24360
Weldability of thermally grain-refined Fe-12Ni-0.25Ti for cryogenic structural applications, 5:24369 (LBL—10259)
IRON IONS/TRANSMISSION
Experimental limits on deviations from Z^2 dependence of Cerenkov radiation by heavy ions, 5:24950
IRON OXIDES/ELECTRIC CONDUCTIVITY
Electrode module materials evaluation, 5:24223 (FE—2215-13(Vol.1))
IRON OXIDES/HOT PRESSING
X-ray induced auger electron spectroscopic studies on aluminum metal surface films in aluminum/iron oxide thermites, 5:24437 (MLM—2711(OP))
IRON OXIDES/PHASE DIAGRAMS
Electrode module materials evaluation, 5:24223 (FE—2215-13(Vol.1))
IRON OXIDES/PHYSICAL RADIATION EFFECTS
X-ray induced auger electron spectroscopic studies on aluminum metal surface films in aluminum/iron oxide thermites, 5:24437 (MLM—2711(OP))
IRON OXIDES/RAMAN SPECTRA
Raman spectroscopy of surface oxides at elevated temperatures, 5:24464
IRON OXIDES/REDUCTION
Method for the direct reduction of iron using gas from coal (Patent), 5:23431
IRON-AIR BATTERIES/ELECTRODES
Iron-air battery characteristics (110 W/kg), 5:24114
IRON-AIR BATTERIES/PERFORMANCE
Iron-air battery characteristics (110 W/kg), 5:24114
IRON-NICKEL BATTERIES/PERFORMANCE
Performance characteristics of iron nickel batteries (109 kWh, 132 V), 5:24136
IRRADIATION CAPSULES/NEUTRON DOSIMETRY
Relating surveillance capsule measurements to pressure vessel damage, 5:24073 (BNL-NUREG—27192)
ISABELLE STORAGE RINGS/ULTRAHIGH VACUUM
Self-modulating ion gauge, 5:24536
Ultrahigh vacuum system for ISABELLE full cell, 5:24535
ISABELLE STORAGE RINGS/VACUUM SYSTEMS
Ultrahigh vacuum system for ISABELLE full cell, 5:24535
ISOCYANATES/CHEMICAL RADIATION EFFECTS
process for coating a substrate with a radiation and moisture curable coating composition (Patent), 5:24503
ISOLATED LOCATIONS
See REMOTE AREAS
ISX TOKAMAK/ECR HEATING
Heating at the electron cyclotron frequency in the ISX-B tokamak, 5:24988
ISX TOKAMAK/ELECTRON TEMPERATURE
Heating at the electron cyclotron frequency in the ISX-B tokamak, 5:24988
ISX TOKAMAK/LIMITERS
Initial testing of coated limiters in ISX-B, 5:25088 (CONF-800455—8)
ISX TOKAMAK/REVIEWS
Review of the ISX-B experimental program, 5:25007
IUS
See TOTAL ENERGY SYSTEMS

J

JET DRILLS
Research and development of a high-pressure waterjet coring device for geothermal exploration and drilling. Final report, February 1976-October 1977, 5:23997 (RLO—2325)
JET ENGINE FUELS/HEALTH HAZARDS
Evaluation of comparative toxicity and shipboard hazards of selected petroleum and oil shale-derived fuels, 5:23655
JET MODEL/QUANTUM CHROMODYNAMICS
Process dependence of perturbative quantum-chromodynamic jet structures, 5:24884

K

K01
See KAONS NEUTRAL SHORT-LIVED
K02
See KAONS NEUTRAL LONG-LIVED
K-892 RESONANCES/PARTICLE WIDTHS
K/sub S/^{0*} and its uses, 5:24860
KANSAS/SEISMICITY
Seismicity of the salt areas of Texas, Louisiana, Oklahoma and Kansas, 5:24785 (UCRL—15221)

KAOLINITE/STRAIN RATE
A study of the permanent effects of elevated temperature on the hydraulic properties of clay. Master's thesis, 5:24463 (PB—300686)
KAONIC ATOMS/X-RAY SPECTRA
X-ray yields in protonium and mesic hydrogen, 5:24818
KAONS NEUTRAL
See also KAONS NEUTRAL LONG-LIVED
KAONS NEUTRAL SHORT-LIVED
KAONS NEUTRAL/HADRONIC PARTICLE DECAY
Gauge models of CP violation, 5:24873
KAONS NEUTRAL LONG-LIVED/PARTICLE DECAY
K/sub S/⁰* and its uses, 5:24860
KAONS NEUTRAL LONG-LIVED/SEMILEPTONIC DECAY
Search for the violation of time-reversal invariance in K⁰/sub mu3/ decays, 5:24847
KAONS NEUTRAL SHORT-LIVED/PARTICLE PRODUCTION
K/sub S/⁰* and its uses, 5:24860
KELP
See SEAWEEDS
KENTUCKY/FOSSIL-FUEL POWER PLANTS
Composition and properties of Kentucky power plant ash, 5:24035 (METC/SP—79/10(Pt.1))
KENTUCKY/MAGNETIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
KENTUCKY/RADIOMETRIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
KIDNEYS/RADIONUCLIDE KINETICS
Distribution and retention of ^{243}⁴Cm in the adult baboon, 5:24756 (COO—3382-18)
Short term kinetics of uranium in the adult baboon: preliminary data, 5:24760 (COO—3382-18)
KIKUCHI LINES/PATTERN RECOGNITION
Indexing of diffracting planes using the Kikuchi pattern, 5:24384
KILNS/DUSTS
Advances in marketing Pozzolanic road bases, 5:23503 (METC/SP—79/10(Pt.2))
KINASES (PHOSPHOTRANSFERASES)
See PHOSPHOTRANSFERASES
KNOCK-ON ELECTRONS
See ELECTRONS
KOPPERS-TOTZEK PROCESS
Koppers-Totzek coal gasification process and its role in today's coal-based nitrogenous fertilizer production, 5:23784
KOPPERS-TOTZEK PROCESS/ENVIRONMENTAL EFFECTS
Operating experience on a 1,000-ton/day ammonia plant at Modderfontein, 5:23790
KOPPERS-TOTZEK PROCESS/OPERATION
Operating experience on a 1,000-ton/day ammonia plant at Modderfontein, 5:23790
KOPPERS-TOTZEK PROCESS/REFRACTORIES
Operating experience on a 1,000-ton/day ammonia plant at Modderfontein, 5:23790
KOPPERS-TOTZEK PROCESS/SYNTHESIS GAS
Final sulfur removal in ammonia from coal plants, 5:23416
KORTEWEG-DE VRIES EQUATION/CONSERVATION LAWS
Simple connection between conservation laws in the Korteweg—de Vriesand sine-Gordon systems, 5:24877
KRYPTON/SEPARATION PROCESSES
Effect of the degree of hydration of the adsorbent on the chromatographic analysis of common gases, 5:24493 (DP-TR—9)
KRYPTON 85/BETA DECAY
Level properties of $^{85}_{37}Rb_{48}$ from the decay of the ^{85}Kr and ^{85}Sr isomers and the cluster-vibration model, 5:24913
KRYPTON ISOTOPES/DAUGHTER PRODUCTS
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)
KRYPTON ISOTOPES/ENVIRONMENTAL TRANSPORT
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)

L

LABORATORY EQUIPMENT
See also MANIPULATORS
VACUUM PUMPS
LABORATORY EQUIPMENT/DESIGN
System for loading slab-gel holders for electrophoresis separation (DOE patent), 5:24492
LAMBDA NEUTRAL
See LAMBDA PARTICLES
LAMBDA PARTICLES/WEAK PARTICLE DECAY
High statistics measurement of the vector and axial vector coupling constraints in lambda beta decay, 5:24849
LAMINAR FLOW/BOUNDARY LAYERS
Nonlinear analysis of laminar boundary layer flow over a periodic wavy surface: Part II: Long waves, 5:24832
LAMINAR FLOW/INCOMPRESSIBLE FLOW
Nonlinear analysis of laminar boundary layer flow over a periodic wavy surface: Part II: Long waves, 5:24832
LAMINOGRAPHY
See TOMOGRAPHY
LAMPF LINAC/PION BEAMS
Investigation of a large solid angle pion channel for a medical application utilizing current sheets and solenoid elements, 5:24554 (LA—8356-MS)
LAMPF LINAC/RESEARCH PROGRAMS
Medium-energy physics program. Quarterly progress report, May 1-July 31, 1979, 5:24553 (LA—8293-PR)
LAND RECLAMATION/ENVIRONMENTAL IMPACTS
Environmental assessment of surface mining methods: head-of-hollow fill and mountaintop removal. Interim report November 1975-January 1977, 5:23525 (PB—300540)
LAND RECLAMATION/REVEGETATION
Application of fly ash and other wastes to mine soils as an aid in revegetation, 5:23517 (METC/SP—79/10(Pt.2))
LAND RECLAMATION/SURFACE MINING ACTS
Mining reclamation laws, 5:23571
LAND USE
Preliminary comparative assessment of land use for the satellite power system (SPS) and alternative electric energy technologies, 5:23848 (DOE/ER—0054)
LAND USE/ENERGY CONSERVATION
Land use controls to save energy, 5:24260
LAND USE/MATHEMATICAL MODELS
National environmental models of agricultural policy, land use and water quality. Progress report no. 4, 5:24649 (PB—300525)
LANDFILLS
See SANITARY LANDFILLS
LANTHANIDES
See RARE EARTHS
LANTHANUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
LANTHANUM ALLOYS/SORPTIVE PROPERTIES
HVEM in situ hydriding of hydrogen storage materials, 5:24394 (CONF-791132—5)
LANTHANUM CHROMITES
See CHROMIUM OXIDES
LARGE COIL PROGRAM/REVIEWS
Progress on large superconducting toroidal field coils, 5:25047 (CONF-791102—164)
LASER FUSION REACTORS/BEAM TRANSPORT
Method and apparatus for timing of laser beams in a multiple laser beam fusion system (Patent), 5:25072
LASER FUSION REACTORS/OPTICAL SYSTEMS
Method and apparatus for timing of laser beams in a multiple laser beam fusion system (Patent), 5:25072
LASER MIRRORS/RESEARCH PROGRAMS
Krypton fluoride laser mirror study. Final report, October 1978-November 1979, 5:24521 (DOE/DP/40001—1)
LASER RADIATION/ABSORPTION
Z dependence of the laser-intensity threshold for inhibited electron thermal conduction, 5:24951
LASER TARGETS/ABLATION
Properties of ablatively accelerated targets, 5:25074 (NRL-MR—4212)
LASER TARGETS/ACCELERATION
Properties of ablatively accelerated targets, 5:25074 (NRL-MR—4212)
LASER TARGETS/DEFECTS
X-ray microradiographs of laser fusion targets: improved image analysis techniques, 5:25079

LASER TARGETS/FABRICATION
Method and apparatus for producing small hollow spheres (Patent), 5:23763
LASER TARGETS/IMAGES
Three-dimensional reconstruction of the x-ray emission in laser imploded targets, 5:25080
LASER TARGETS/MICRORADIOGRAPHY
X-ray microradiographs of laser fusion targets: improved image analysis techniques, 5:25079
LASER TARGETS/X-RAY RADIOGRAPHY
X-ray microradiographs of laser fusion targets: improved image analysis techniques, 5:25079
LASER TARGETS/X-RAY SPECTRA
Three-dimensional reconstruction of the x-ray emission in laser imploded targets, 5:25080
LASER-PRODUCED PLASMA/ABLATION
Laser-plasma interaction and ablative acceleration of thin foils at 10^{12}—10^{15} W/cm^2, 5:25082
LASER-PRODUCED PLASMA/PLASMA ACCELERATION
Laser-plasma interaction and ablative acceleration of thin foils at 10^{12}—10^{15} W/cm^2, 5:25082
LASER-PRODUCED PLASMA/PLASMA EXPANSION
High-energy ion expansion in laser-plasma interactions, 5:25023
LASER-PRODUCED PLASMA/SYNCHROTRON RADIATION
Inverse synchrotron interaction, 5:25041
LASER-PRODUCED PLASMA/X-RAY SPECTRA
Hard x-ray spectrum from a one-fluid laser plasma model, 5:25014 (NRL-MR—4241)
LASER-RADIATION HEATING
Multiple-pass carbon dioxide laser heating of a theta-pinch plasma, 5:24990
Numerical analysis of high power laser propagation in magnetized plasmas, 5:25037
LASER-RADIATION HEATING/PLASMA SIMULATION
Randomness, Maxwellian distributions and resonance absorption, 5:24989
LASER-RADIATION HEATING/RAMAN EFFECT
Heating by the Raman instability, 5:24983 (UCRL—84270)
LASERS
See also CARBON DIOXIDE LASERS
CHEMICAL LASERS
GAS LASERS
LASERS/MATHEMATICAL MODELS
Multipass amplifier: Theory and numerical analysis, 5:24526
LASERS/POPULATION INVERSION
Two-stage pumping of three-level Moessbauer gamma-ray lasers, 5:24525
LASL
(Los Alamos Scientific Laboratory.)
LASL/RADIOACTIVE WASTE MANAGEMENT
Performance and improvements of the tritium handling facility at the Los Alamos Scientific Laboratory, 5:23721 (LA-UR—80-1265)
LATENT HEAT STORAGE
Heat transfer and calorimetric studies of a direct contact-latent heat energy storage system, 5:23977
LATENT HEAT STORAGE/PHASE CHANGE MATERIALS
Some observations on a paraffin-wax phase change experiment, 5:24100 (CONF-791108—24)
LATTICE FIELD THEORY/COUPLING CONSTANTS
Monte Carlo study of quantized SU(2) gauge theory, 5:24881
LATTICE FIELD THEORY/FEYNMAN PATH INTEGRAL
Monte Carlo study of quantized SU(2) gauge theory, 5:24881
LATTICE FIELD THEORY/GAUGE INVARIANCE
Phase diagram of Z(N) and U(1) gauge theories in three dimensions, 5:24879
LATTICE FIELD THEORY/ORTHOGONAL TRANSFORMATIONS
Orthogonal transforms and lattice field theories, 5:24878
LATTICE FIELD THEORY/RENORMALIZATION
Monte Carlo study of quantized SU(2) gauge theory, 5:24881
LATTICE FIELD THEORY/SPACE-TIME
Phase diagram of Z(N) and U(1) gauge theories in three dimensions, 5:24879
LATTICE FIELD THEORY/U-1 GROUPS
Phase diagram of Z(N) and U(1) gauge theories in three dimensions, 5:24879
LATTICES (CRYSTAL)
See CRYSTAL LATTICES
LAUNDRIES/SOLAR PROCESS HEAT
Solar production of industrial process steam for The Home Laundry, 5:23927 (SERI/TP—333-429)
Solar supplement to laundry drying, 5:23915 (SERI/TP—333-429)
LAWRENCE BERKELEY LABORATORY/ACCELERATOR FACILITIES
Research/Accelerators. Bimonthly status report of operations, November-December 1979. Volume 4, Number 6, 5:24555 (LBL-PUB—300)
LAWRENCE BERKELEY LABORATORY/RESEARCH PROGRAMS
Research/Accelerators. Bimonthly status report of operations, November-December 1979. Volume 4, Number 6, 5:24555 (LBL-PUB—300)
LEACHATES/CHEMICAL COMPOSITION
Environmental research on a modified in situ oil shale task process. Progress report, 5:23660 (DOE/EV—0078)
LEACHATES/HEALTH HAZARDS
Environmental research on a modified in situ oil shale task process. Progress report, 5:23660 (DOE/EV—0078)
LEACHATES/TESTING
Materials Characterization Center workshop on leaching of radioactive waste forms. Summary report, 5:23738 (PNL—3318)
LEAD/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
LEAD/EXCRETION
Distribution and excretion of lead in young and adult female mice, 5:24772
LEAD/EXPLOSION WELDING
Viscosity of metals in explosive welding, 5:24371 (UCRL-Trans—11542)
LEAD/METABOLISM
Lead transfer in maternal milk, and the absorption, retention, distribution and excretion of lead in suckling mice, 5:24771 (UR—3490-1798)
Metals in soft tissues of mule deer and antelope, 5:24775
LEAD/TISSUE DISTRIBUTION
Distribution and excretion of lead in young and adult female mice, 5:24772
LEAD 208/HIGH SPIN STATES
Investigation of natural-parity high-spin states in ^{208}Pb by (e,e') reactions, 5:24931
LEAD 208/NUCLEAR RADII
Sub-Coulomb transfer reactions on ^{208}Pb with carbon and oxygen projectiles, 5:24933
LEAD 208 REACTIONS/COMPOUND-NUCLEUS REACTIONS
Exactly central heavy-ion collisions by nuclear hydrodynamics, 5:24928
LEAD 208 TARGET/ELECTRON REACTIONS
Investigation of natural-parity high-spin states in ^{208}Pb by (e,e') reactions, 5:24931
LEAD 208 TARGET/LEAD 208 REACTIONS
Exactly central heavy-ion collisions by nuclear hydrodynamics, 5:24928
LEAD 208 TARGET/PION MINUS REACTIONS
Interpretation of quasielastic pion scattering coincidence experiments, 5:24893
LEAD 208 TARGET/PION PLUS REACTIONS
Interpretation of quasielastic pion scattering coincidence experiments, 5:24893
LEAD CHLORIDES/BIOLOGICAL EFFECTS
Effects of divalent metal chlorides on respiration and extractable enzymatic activities of douglas-fir needle litter, 5:24769
LEAD-ACID BATTERIES/USES
Simulation of an urban battery bus vehicle. Final report June-December 1978, 5:24345 (PB—300306)
LEASING/SOCIO-ECONOMIC FACTORS
Alaska OCS Socioeconomic Studies Program. Technical rept. No. 38. Western Gulf of Alaska petroleum development scenarios: economic and demographic impacts, 5:23602 (PB—300697)
Alaska OCS socioeconomic studies program. Technical report No. 36. Northern Gulf of Alaska petroleum development scenarios: sociocultural impacts, 5:23603 (PB—300699)
Alaska OCS socioeconomic studies program. Technical report No. 43. Lower Cook Inlet and Shelikof Strait petroleum development scenarios. Final report, 5:23604 (PB—300701)
LEASING/STATISTICAL MODELS
Modeling the number of bids received on federal offshore hydrocarbon leases by poisson-type models, 5:23601 (LA—8347-MS)
LEED
See ELECTRON DIFFRACTION
LEPTONS
See also ELECTRONS
NEUTRINOS
LEPTONS/PARTICLE PRODUCTION
Sources of prompt leptons in hadronic collisions, 5:24850
LETHAL MUTATIONS/RADIOINDUCTION
Analysis of the albino-locus region of the mouse. III. Time of death of prenatal lethals, 5:24750
LEVULOSE
See FRUCTOSE
LIGANDS/BIOCHEMICAL REACTION KINETICS
Ligated chlorophyll cation radicals: their function in photosystem II of plant photosynthesis, 5:24680

LIGHT
See VISIBLE RADIATION
LIGHT EMITTING DIODES/ELECTROCHEMISTRY
Electrochemical light-emitting diodes, 5:24500
LIGHT WATER BREEDER REACTORS
See LWBR TYPE REACTORS
LIGHTING SYSTEMS/ENERGY CONSERVATION
Evaluation of the State Energy Conservation Program from program initiation to September 1978. Final report, 5:24191 (DOE/CS/1697—01)
Multifrequency factory operations. Final report, 5:24303 (SAN—1731-T3)
LIGHTNING ARRESTERS/CONNECTORS
Glass-ceramics for lightning arrestor connector seals, 5:24429 (SAND—80-0215)
LIGNITE/CHEMICAL COMPOSITION
Inorganic constituents in American lignites, 5:23456 (FE—2030-TR21)
LIMESTONE/AVAILABILITY
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 1. Task I report: literature review, basis for selecting calcium-based sorbents. Final report, 5:24032 (EPRI-FP—1307(Vol.1))
LIMESTONE/CHEMICAL ANALYSIS
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 2. Tasks II and III report: experimental work, sorbent selection technique. Final report, November 1, 1976-July 31, 1977, 5:24033 (EPRI-FP—1307(Vol.2))
LIMESTONE/PHYSICAL PROPERTIES
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 1. Task I report: literature review, basis for selecting calcium-based sorbents. Final report, 5:24032 (EPRI-FP—1307(Vol.1))
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 2. Tasks II and III report: experimental work, sorbent selection technique. Final report, November 1, 1976-July 31, 1977, 5:24033 (EPRI-FP—1307(Vol.2))
LIMESTONE/SORPTIVE PROPERTIES
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 2. Tasks II and III report: experimental work, sorbent selection technique. Final report, November 1, 1976-July 31, 1977, 5:24033 (EPRI-FP—1307(Vol.2))
LIMITERS/COATINGS
Development and laboratory testing of low Z refractory coatings for fusion reactor limiters, 5:25093 (SAND—79-2409C)
Initial testing of coated limiters in ISX-B, 5:25088 (CONF-800455—8)
Testing of low Z coated limiters in tokamak fusion devices, 5:25092 (SAND—79-2105C)
LIMITERS/SUBLIMATION
Thermal responses of first wall limiters in the Tokamak Fusion Test Reactor, 5:25100
LINACS
See LINEAR ACCELERATORS
LINEAR ACCELERATORS
See also FMIT LINAC
LAMPF LINAC
LINEAR ACCELERATORS/INSTABILITY
Longitudinal instabilities of pulseline driven neutralized linear ion accelerators, 5:24548
LINEAR ACCELERATORS/ION BEAMS
Production and postacceleration of intense ion beams in magnetically insulated gaps, 5:24550
LINEAR ACCELERATORS/PULSES
Longitudinal instabilities of pulseline driven neutralized linear ion accelerators, 5:24548
LINEAR Z PINCH DEVICES/FLUTE INSTABILITY
Growth rates of interchange modes in the dense z-pinch and gas blanket effects, 5:25024 (LA—8340-MS)
LINEAR-SEGMENTED ARRAY COLLECTOR
See SLAT TYPE COLLECTORS
LIPOPROTEINS/MORPHOLOGY
Changes in plasma lipoprotein distribution and formation of two unusual particles after heparin-induced lipolysis in hypertriglyceridemic subjects, 5:24718
LIPOPROTEINS/TISSUE DISTRIBUTION
Changes in plasma lipoprotein distribution and formation of two unusual particles after heparin-induced lipolysis in hypertriglyceridemic subjects, 5:24718
LIQUEFACTION
See also COAL LIQUEFACTION
LIQUEFACTION/PROCESS DEVELOPMENT UNITS
Catalytic biomass liquefaction, 5:23836 (LBL—10667)
LIQUEFIED NATURAL GAS/STORAGE
Liquefied natural gas tank construction (Patent), 5:23614
LIQUID CRYSTALS/CRYSTAL STRUCTURE
Unified model of the smectic-A, nematic, and isotropic phases for bulk, interfaces, and thin films: Bulk, 5:24956
LIQUID CRYSTALS/PHASE TRANSFORMATIONS
Unified model of the smectic-A, nematic, and isotropic phases for bulk, interfaces, and thin films: Bulk, 5:24956
LIQUID METAL FAST BREEDER REACTORS
See LMFBR TYPE REACTORS
LIQUID METAL TEST FACILITIES
See TEST FACILITIES
LIQUID METALS/DENSITY
Extension of liquid-metal theory to dense partially ionized plasmas, 5:24834
LIQUID METALS/THERMODYNAMIC PROPERTIES
Extension of liquid-metal theory to dense partially ionized plasmas, 5:24834
LIQUID SCINTILLATION DETECTORS/ENERGY RESOLUTION
Alpha liquid scintillation counting: past, present, and future, 5:24560 (CONF-790859—3)
New advanced in alpha spectrometry by liquid scintillation methods, 5:24559 (CONF-791117—26)
LIQUID WASTES
See also WASTE WATER
LIQUID WASTES/WASTE PROCESSING
Evaluation of the ultraviolet-ozone and ultraviolet-oxidant treatment of pink water. Final report 6 June 1976-30 December 1977, 5:24317 (PB—300763)
LIQUIDS
See also LIQUID CRYSTALS
LIQUID METALS
LIQUIDS/RAMAN EFFECT
Critical test of vibrational dephasing theories in liquids by use of selective, coherent, picosecond Stokes scattering, 5:24476
LIQUIDS/VIBRATIONAL STATES
Critical test of vibrational dephasing theories in liquids by use of selective, coherent, picosecond Stokes scattering, 5:24476
LITHIUM/DENSITY
Extension of liquid-metal theory to dense partially ionized plasmas, 5:24834
LITHIUM/EMISSION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
LITHIUM/PASSIVATION
Passivating layer on lithium in lithium tetrachloroaluminate-$SOCl_2$ solutions, 5:24170
LITHIUM/PROTON REACTIONS
Asymmetry in total scattering of polarized protons by nuclei at 2.1 GeV/s, 5:24839 (LA-tr—80-12)
LITHIUM/SOLVENTS
Method of forming single crystals of beta silicon carbide (Patent), 5:24426
LITHIUM/THERMODYNAMIC PROPERTIES
Extension of liquid-metal theory to dense partially ionized plasmas, 5:24834
LITHIUM 5/ENERGY LEVELS
(π,p) absorption in /sup 6,7/Li at 75 and 175 MeV, 5:24889
LITHIUM 6/ENERGY LEVELS
(π,p) absorption in /sup 6,7/Li at 75 and 175 MeV, 5:24889
LITHIUM 6 REACTIONS/ELASTIC SCATTERING
Vector analyzing power in the elastic scattering of ^{6}Li(pol) by ^{4}He (15.1 to 22.7 MeV, L-S coupling), 5:24892
LITHIUM 6 TARGET/PION MINUS REACTIONS
(π,p) absorption in /sup 6,7/Li at 75 and 175 MeV, 5:24889
LITHIUM 6 TARGET/PION PLUS REACTIONS
(π,p) absorption in /sup 6,7/Li at 75 and 175 MeV, 5:24889
LITHIUM 7 TARGET/PION PLUS REACTIONS
(π,p) absorption in /sup 6,7/Li at 75 and 175 MeV, 5:24889
LITHIUM 7 TARGET/PION REACTIONS
Pion absorption processes (32 to 74 MeV), 5:24896 (COO—3244-72)
LITHIUM BASE ALLOYS/FABRICATION
Lithium-boron alloy: a new battery anode material (80% Li), 5:24161
LITHIUM BORIDES/FABRICATION
Lithium-boron alloy: a new battery anode material (80% Li), 5:24161
LITHIUM COMPOUNDS/FABRICATION
Advanced fuel cell development. Progress report, July-September 1979 (Molten carbonate fuel cells), 5:24233 (ANL—79-110)
Advanced fuel cell development. Progress report, April-June 1979 (Molten carbonate fuel cells), 5:24232 (ANL—79-84)
LITHIUM COMPOUNDS/MICROSTRUCTURE
Comparative analysis of the cellular and Johnson-Mehl microstructures through computer simulation, 5:24376
LITHIUM COMPOUNDS/PHYSICAL PROPERTIES
Advanced fuel cell development. Progress report, April-June 1979 (Molten carbonate fuel cells), 5:24232 (ANL—79-84)

LITHIUM-SULFUR BATTERIES/BATTERY CHARGERS
System and method for charging electrochemical cells in series (Patent application), 5:24154
LITHIUM-SULFUR BATTERIES/CATHODES
Transition metal sulfide-lithium organic electrolyte rechargeable cells ($CuCo_2S_4$), 5:24165
LITHIUM-SULFUR BATTERIES/CONTAINERS
Analysis of an internally pressurized prismatic cell can, 5:24156 (ANL—80-30)
LITHIUM-SULFUR BATTERIES/DESIGN
Design and testing of a large-scale lithium-silicon/FeS load-leveling cell (2.5 kWh), 5:24104
LITHIUM-SULFUR BATTERIES/ELECTROLYTES
Electrolysis of molten $NaNO_3$-$AgNO_3$ as test of a model of transport in batteries, 5:24122 (CONF-781063—7)
LITHIUM-SULFUR BATTERIES/MASS TRANSFER
Electrolysis of molten $NaNO_3$-$AgNO_3$ as test of a model of transport in batteries, 5:24122 (CONF-781063—7)
LITHIUM-SULFUR BATTERIES/PERFORMANCE
Characteristics of the aluminium-lithium/iron sulfide cells in immobilised salt electrolytes (130 Wh/kg), 5:24125
LITHIUM-SULFUR BATTERIES/PERFORMANCE TESTING
Design and testing of a large-scale lithium-silicon/FeS load-leveling cell (2.5 kWh), 5:24104
LITHIUM-SULFUR BATTERIES/POWER SUBSTATIONS
Conceptual design of electrical balance of plant for advanced battery energy storage facility. Annual report, March 1979 (20-MW, 100 MWh), 5:24155 (ANL—80-16)
LITHIUM-SULFUR BATTERIES/RESEARCH PROGRAMS
Development of advanced batteries at Argonne National Laboratory. Summary report for 1979 (Li-Al/LiCl-KCl/FeS or FeS_2, 40 kWh; also Ca-Si/FeS_2), 5:24103 (ANL—80-32)
LITHIUM-WATER-AIR BATTERIES/DESIGN
Development of a lithium-water-air battery (To be mechanically rechargeable), 5:24119
LITHIUM-WATER-AIR BATTERIES/PERFORMANCE
Development of a lithium-water-air battery (To be mechanically rechargeable), 5:24119
LIVER/DELAYED RADIATION EFFECTS
Long-term effects of radium exposure in female dial workers: liver function and liver disease, 5:24778
LIVER/RADIONUCLIDE KINETICS
Distribution and retention of ^{243} ^{4}Cm in the adult baboon, 5:24756 (COO—3382-18)
Metabolism of americium-241 in man: an unusual case of internal contamination of a child and his father, 5:24752 (COO—3382-18)
Short term kinetics of uranium in the adult baboon: preliminary data, 5:24760 (COO—3382-18)
LMFBR TYPE REACTORS
See also BN-350 REACTOR
BOR-60 REACTOR
CLINCH RIVER BREEDER REACTOR
EBR-2 REACTOR
LMFBR TYPE REACTORS/CLEANING
Evaporative removal of sodium from reactor components, 5:24064
LMFBR TYPE REACTORS/FABRICATION
Alloys for a liquid metal fast breeder reactor (Patent), 5:24372
LMFBR TYPE REACTORS/FAILED ELEMENT DETECTION
Development of a methodology for analysis of delayed-neutron signals, 5:24051 (ANL—79-57)
LMFBR TYPE REACTORS/FUEL ASSEMBLIES
Heat-transfer in a partially-blocked sodium-cooled rod bundle, 5:24053 (CONF-791205—23)
LMFBR TYPE REACTORS/FUEL CANS
Alloys for a liquid metal fast breeder reactor (Patent), 5:24372
LMFBR TYPE REACTORS/FUEL PINS
TEMP: a computer code to calculate fuel pin temperatures during a transient, 5:24093 (HEDL-TME—75-85)
LMFBR TYPE REACTORS/MELTDOWN
Growth of molten core debris pools in concrete. Part II. A. Pool growth in composite beds; B. Effect of overlaying steel layers. Final report, March 1, 1978-September 30, 1979, 5:24090 (COO—4261-14)
LMFBR TYPE REACTORS/REACTOR COMPONENTS
Accurate numerical solutions for elastic-plastic models, 5:24052 (ANL—80-31)
LMFBR TYPE REACTORS/REACTOR CORE DISRUPTION
Chemical simulation modeling of heat transfer in LMFBRs, 5:24091 (DOE/ET/37205—T1)
Improvement and verification of fast reactor safety analysis techniques. Progress report, October 1, 1979-March 31, 1980, 5:24089 (COO—2571-19)
Nonequilibrium phenomena in flashing water used as an HCDA source simulant. Technical report No. 8, 5:24096 (SAN—0115-T7)
ORNL experiments to characterize fuel release from the reactor primary containment in severe LMFBR accidents, 5:24086 (CONF-800434—2)
LMFBR TYPE REACTORS/REACTOR MATERIALS
Thermal conductivities of mixed carbide fuel and blanket materials, 5:24058 (LA-UR—80-1283)
LMFBR TYPE REACTORS/SHIELDING
Deep penetration calculations, 5:24057 (LA-UR—80-1159)
LMFBR TYPE REACTORS/STEAM GENERATORS
Progress of LMFBR steam generator testing in the US, 5:24056 (GEFR-SP—196)
LMFBR TYPE REACTORS/TRANSIENTS
Plenum-2A, a program for transient analysis of liquid-metal fast breeder reactor outlet plenums, 5:24062
TEMP: a computer code to calculate fuel pin temperatures during a transient, 5:24093 (HEDL-TME—75-85)
LNG
See LIQUEFIED NATURAL GAS
LOADING (REACTOR)
See REACTOR FUELING
LOFRECO PROCESS
Progress report on the geokinetics horizontal in situ retorting process, 5:23631
LOFT REACTOR
Modeling a nuclear reactor for experimental purposes, 5:24087 (CONF-800536—1)
LOFT REACTOR/CONTROL THEORY
Operator support through modern optimal estimation and control, 5:24078 (CONF-800627—1)
LOFT REACTOR/FLOWMETERS
LOFT Experimental Programs Division. Volume II. Calibration of the LOFT modular DTT and the LOFT production DTT with a small drag disc, 5:24081 (EGG/LTR-LO—0080-113)
LOFT REACTOR/REACTOR CONTROL SYSTEMS
Operator support through modern optimal estimation and control, 5:24078 (CONF-800627—1)
LOS ALAMOS MESON PHYSICS FACILITY
See LAMPF LINAC
LOSS OF COOLANT/ACTIVITY LEVELS
Best-estimate LOCA radiation signature for equipment qualification (PWR; BWR), 5:24097 (SAND—80-0888C)
LOSS OF COOLANT/HEAT TRANSFER
Modeling a nuclear reactor for experimental purposes (PWR), 5:24087 (CONF-800536—1)
LOSS OF COOLANT/HYDRAULICS
Modeling a nuclear reactor for experimental purposes (PWR), 5:24087 (CONF-800536—1)
LOSS OF COOLANT/MOCKUP
Modeling a nuclear reactor for experimental purposes (PWR), 5:24087 (CONF-800536—1)
LOSS OF FLUID TEST REACTOR
See LOFT REACTOR
LOUISIANA/SEISMICITY
Seismicity of the salt areas of Texas, Louisiana, Oklahoma and Kansas, 5:24785 (UCRL—15221)
LOW BTU GAS/COMBUSTION PRODUCTS
High temperature gas turbine engine component materials testing program: Task I. Fireside I. Final report, 5:24017 (FE—1765-44)
LOW INCOME GROUPS/ENERGY CONSERVATION
Residential energy conservation. Volume II. Working papers, 5:24257 (PB—301200)
LOW INCOME GROUPS/FEDERAL ASSISTANCE PROGRAMS
Crisis intervention programs in Federal Region III: a policy perspective, 5:24180 (PB—300758)
LOW INCOME GROUPS/HOUSES
Weatherization training; a notebook for weatherization. Supplement Number 3: [illegible]ortation, 5:24256 (PB—301143)
LOW-LEVEL RADIOACTIVE WASTES/EVAPORATION
Environmental sampling program for a solar evaporation pond for liquid radioactive wastes, 5:23729 (LA—8177)
LUBRICATING OILS/ADDITIVES
Grafted copolymers and their use as additives for lubricating oils (Patent), 5:23596
LUBRICATING OILS/PRODUCTION
Production of lubricants (Patent), 5:23589
LUBRICATING OILS/STABILITY
Method of stabilizing lube oils (Patent), 5:23597
LUMINESCENT CONCENTRATORS/DESIGN
Luminescent solar collector (Patent), 5:23826
Solar collector structures containing thin film polysiloxane, and solar cells (Patent), 5:23829
LUMINESCENT CONCENTRATORS/EFFICIENCY
Luminescent solar collector (Patent), 5:23826
LUNGS/BIOLOGICAL RADIATION EFFECTS
Induction of lung tumors in RFM mice after localized exposures to x rays or neutrons, 5:24748

LUNGS/FRACTIONATED IRRADIATION
Results of a pilot study with extended fractionation in the treatment of lung cancer, 5:24746
LUNGS/RADIONUCLIDE KINETICS
Metabolism of americium-241 in man: an unusual case of internal contamination of a child and his father, 5:24752 (COO—3382-18)
LURGI PROCESS/SYNTHESIS GAS
Final sulfur removal in ammonia from coal plants, 5:23416
LUTETIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
LWBR TYPE REACTORS/THORIUM CYCLE
Nuclear technology developments affecting uranium needs, 5:23672
LYMPHOCYTES/IMMUNE REACTIONS
Inhibition of cytotoxic T lymphocytes with concanavalin A, 5:24703
LYMPHOID CELLS
See LYMPHOCYTES

M

MA 754
See NICKEL BASE ALLOYS
MA 956
See IRON BASE ALLOYS
MACROPHAGES/COLONY FORMATION
Absence of erythroblastic islands in plasma clot culture nd their possible reconstitution after clot lysis, 5:24729
MAGNESIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
MAGNESIUM 24/ENERGY LEVELS
$^{12}C + ^{12}C$ intermediate structures correlated among elastic and reaction channels, 5:24894
$^{24}Mg(^{16}O,^{12}C)^{28}Si$ and $^{24}Mg(^{16}O,^{16}O)^{24}Mg$ reactions at backward angles, 5:24904
MAGNESIUM 24 TARGET/CARBON 12 REACTIONS
Resonances in ^{36}Ar via the $^{24}Mg(^{12}C, \alpha)^{32}S$ reaction (27.5 to 35.5 MeV, excitation functions, angular distributions), 5:24909
MAGNESIUM 24 TARGET/OXYGEN 16 REACTIONS
$^{24}Mg(^{16}O,^{12}C)^{28}Si$ and $^{24}Mg(^{16}O,^{16}O)^{24}Mg$ reactions at backward angles, 5:24904
Resonant behavior of the $^{24}Mg(^{16}O,^{12}C)^{28}Si$ reaction, 5:24905
MAGNESIUM 24 TARGET/OXYGEN 18 REACTIONS
Complete fusion of $^{18}N + ^{27}Al$, 5:24906
MAGNESIUM 25/MOMENT OF INERTIA
$^{12}C(^{13}C, \alpha)^{21}Ne$ reaction. High-spin states, resonances and coherence widths, 5:24900
MAGNESIUM 26 TARGET/OXYGEN 16 REACTIONS
Complete fusion of $^{15}N + ^{27}Al$, 5:24906
MAGNESIUM OXIDES/CORROSION
Refractory materials for coal fueled mhd power generation. Final report, 5:24436 (PB—301095)
MAGNETIC BREMSSTRAHLUNG
See SYNCHROTRON RADIATION
MAGNETIC ENERGY STORAGE
Inductive storage-prospects for high power generation, 5:25056
MAGNETIC FIELD REVERSAL
Production of field-reversed configurations with a magnetized coaxial plasma gun, 5:25049 (LA-UR—80-1104)
MAGNETIC MIRROR CONFIGURATIONS/HIGH-FREQUENCY HEATING
Rf heating of mirrors, 5:24982 (UCID—18623)
MAGNETIC MIRROR CONFIGURATIONS/STABILIZATION
Shear stabilized cylindrically symmetric mirror plasma, 5:25031
MAGNETIC MIRROR TYPE REACTORS
See also FIELD-REVERSED MIRROR REACTORS
TMR REACTORS
MAGNETIC MIRROR TYPE REACTORS/CRITICALITY
Accidental criticality of a fusion-fission hybrid blanket design, 5:25070
MAGNETIC MIRROR TYPE REACTORS/ECONOMICS
Some implications for mirror research of the coupling between fusion economics and fusion physics, 5:25045 (UCRL—84245)
MAGNETIC MIRROR TYPE REACTORS/REVIEWS
Some implications for mirror research of the coupling between fusion economics and fusion physics, 5:25045 (UCRL—84245)
MAGNETIC MIRRORS
See also MFTF DEVICES
TMX DEVICES
MAGNETIC MIRRORS/PLASMA CONFINEMENT
Generating end plug potentials in tandem mirror plasma confinement by heating thermal particles so as to escape low density end stoppering plasmas (Patent), 5:24977
Plasma confinement apparatus using solenoidal and mirror coils (Patent), 5:25046
Production of field-reversed mirror plasma with a coaxial plasma gun (Patent), 5:24976
MAGNETIC MIRRORS/PLUGGING
Generating end plug potentials in tandem mirror plasma confinement by heating thermal particles so as to escape low density end stoppering plasmas (Patent), 5:24977
MAGNETIC MIRRORS/SPECIFICATIONS
Plasma confinement apparatus using solenoidal and mirror coils (Patent), 5:25046
MAGNETIC MIRRORS/STABILITY
Stability of long, thin axisymmetric mirror machines, 5:25030
MAGNETIC MONOPOLES/PARTICLE PRODUCTION
Phase transitions and magnetic monopole production in the very early universe, 5:24800
MAGNETIC PROPERTIES/MEASURING INSTRUMENTS
Micromagnetic susceptometer (4.2 to 300 K), 5:24578
MAGNETOHYDRODYNAMIC CHANNELS
See MHD CHANNELS
MAGNETOHYDRODYNAMIC GENERATORS
See MHD GENERATORS
MAGNETOHYDRODYNAMICS/DIFFERENTIAL EQUATIONS
Local sufficient condition for magnetohydrodynamic stability of closed line systems, 5:25027
MAGNETOHYDRODYNAMICS/SUYDAM CRITERION
Persistence of magnetohydrodynamic stability in field reversed pinches against microinstability, 5:25028
MAGNETOMETERS/DESIGN
Micromagnetic susceptometer (4.2 to 300 K), 5:24578
MAGNETOMETERS/SENSITIVITY
Micromagnetic susceptometer (4.2 to 300 K), 5:24578
MAGNETOTELLURIC SURVEYS/DATA ANALYSIS
Magnetotelluric data analysis: removal of bias, 5:24790
MAGNETOTELLURIC SURVEYS/DATA PROCESSING
Magnetotellurics with a remote magnetic reference, 5:24788
MAIZE/PRODUCTION
Resource-conserving agricultural production methods. Progress report August 1977-July 1978, 5:24301 (PB—301042)
MAN/RADIONUCLIDE KINETICS
Improved mathematical model for uranium metabolism, 5:24753 (COO—3382-18)
Metabolism of americium-241 in man: an unusual case of internal contamination of a child and his father, 5:24752 (COO—3382-18)
Radioactivity studies progress report (Lead abstract), 5:24755 (COO—3382-18)
MANGANESE/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
MANGANESE/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
MANGANESE/EMISSION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
MANGANESE/METABOLISM
Metals in soft tissues of mule deer and antelope, 5:24775
MANGANESE ALLOYS/EXPANSION
Hydrogen attack of HSLA steels, 5:24390
MANGANESE ALLOYS/FRACTURE PROPERTIES
Structure-property relations and the design of Fe-4Cr-C base structural steels for high strength and toughness, 5:24378
MANGANESE ALLOYS/MICROSTRUCTURE
Structure-property relations and the design of Fe-4Cr-C base structural steels for high strength and toughness, 5:24378
MANGANESE ALLOYS/PHYSICAL RADIATION EFFECTS
Swelling and phase instability in neutron irradiated compositional variants of alloy D9, 5:24420 (DOE/TIC—11202)
MANGANIN/HYSTERESIS
Hysteresis-corrected calibration of manganin under shock loading, 5:24296
MANGANIN/IMPACT SHOCK
Hysteresis-corrected calibration of manganin under shock loading, 5:24296
MANIPULATORS/DESIGN
Method and apparatus for recovery of subsea well equipment (Patent), 5:23582

MANPOWER/EDUCATION
Manpower for the coal mining industry: an assessment of adequacy through the year 2000. Volume II. Technical approach. Final technical report (USA; forecasting), 5:23537 (FE—3134-2)
Manpower for the coal mining industry: an assessment of adequacy through the year 2000. Volume I. Executive summary. Final technical report (USA; forcasting), 5:23536 (FE—3134-1)
MANPOWER/SUPPLY AND DEMAND
Manpower for the coal mining industry: an assessment of adequacy through the year 2000. Volume II. Technical approach. Final technical report (USA; forecasting), 5:23537 (FE—3134-2)
Manpower for the coal mining industry: an assessment of adequacy through the year 2000. Volume I. Executive summary. Final technical report (USA; forcasting), 5:23536 (FE—3134-1)
MANUALS/RECOMMENDATIONS
Need for a contamination control textbook, 5:24517 (UCRL—84327)
MANURES/WASTE PRODUCT UTILIZATION
Application of fly ash and other wastes to mine soils as an aid in revegetation, 5:23517 (METC/SP—79/10(Pt.2))
MANY-BODY PROBLEM/SCATTERING AMPLITUDES
Wave-function formalisms in the channel coupling array theory of many-body scattering, 5:24942
MANY-BODY PROBLEM/WAVE FUNCTIONS
Wave-function formalisms in the channel coupling array theory of many-body scattering, 5:24942
MARICULTURE
See AQUACULTURE
MARINE ECOSYSTEMS
See AQUATIC ECOSYSTEMS
MARITIME TRANSPORT/COMPETITION
Economics of oceanborne coal transportation, 5:23546
MARITIME TRANSPORT/ECONOMIC ANALYSIS
Economics of oceanborne coal transportation, 5:23546
MARITIME TRANSPORT/FORECASTING
Economics of oceanborne coal transportation, 5:23546
MARKET SHARES
See COMPETITION
MARYLAND/MAGNETIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
MARYLAND/RADIOMETRIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
MASS SPECTROMETERS
UNISOR facility: recent developments and future directions, 5:24552 (CONF-790976—10)
MASS TRANSIT SYSTEMS/ECONOMIC ANALYSIS
Energy study of automated guideway transit (AGT) systems, 5:24271 (SAN—1176-T3)
MASS TRANSIT SYSTEMS/ENERGY CONSUMPTION
Energy study of automated guideway transit (AGT) systems, 5:24271 (SAN—1176-T3)
MASSACHUSETTS/STATIONARY POLLUTANT SOURCES
Inventory of sources with emissions of 25 to 100 tons per year subject to organic material regulations in Metropolitan Boston AQCR. Final report, 5:24618 (PB—301242)
MASSACHUSETTS INSTITUTE TECHN. ALCATOR
See ALCATOR DEVICE
MASSIVE VECTOR MESON MODEL
See GLUON MODEL
MATERIALS
See also BUILDING MATERIALS
GLAZING MATERIALS
PHASE CHANGE MATERIALS
POROUS MATERIALS
MATERIALS/DIFFUSION
Effective diffusion coefficients of point defects in impure materials, 5:24375 (ORNL/TM—7247)
MATERIALS/POINT DEFECTS
Effective diffusion coefficients of point defects in impure materials, 5:24375 (ORNL/TM—7247)
MATERIALS HANDLING
Economic and environmental aspects of a new coal ash recycling/disposal process (Ashes or fly ash; wet or dry), 5:23481 (METC/SP—79/10(Pt.1))
MATERIALS RECOVERY/COMPARATIVE EVALUATIONS
Engineering analysis and comparison of new processes for the recovery of resource materials from coal ash (Lime-soda, salt-soda, nitric acid, Calsinter and Bayer processes), 5:23465 (METC/SP—79/10(Pt.1))
Recovery of resource materials from coal ash, 5:23470 (METC/SP—79/10(Pt.1))
MATERIALS RECOVERY/ECONOMICS
Engineering analysis and comparison of new processes for the recovery of resource materials from coal ash (Lime-soda, salt-soda, nitric acid, Calsinter and Bayer processes), 5:23465 (METC/SP—79/10(Pt.1))
MATERIALS RECOVERY/FEASIBILITY STUDIES
Engineering analysis and comparison of new processes for the recovery of resource materials from coal ash (Lime-soda, salt-soda, nitric acid, Calsinter and Bayer processes), 5:23465 (METC/SP—79/10(Pt.1))
MATERIALS TESTING
See also NONDESTRUCTIVE TESTING
MATERIALS TESTING/STANDARDIZATION
Materials Characterization Center workshop on leaching of radioactive waste forms. Summary report, 5:23738 (PNL—3318)
MATERIALS WORKING
(Covers metal and non-metal working.)
MATERIALS WORKING/ENERGY CONSERVATION
Potential for energy conservaton in the metal forming industries. Progress report, July 1, 1978-August 15, 1979, 5:24297 (COO—4930-1)
MATRICES/COMPUTER CALCULATIONS
Odd-even reduction for banded linear equations, 5:25114
MEASURING METHODS/COMPARATIVE EVALUATIONS
Best approach to impact assessment is to use empirically based or simulation models to forecast impacts. Environmental Sciences Division Publication No. 1538 (Concerning the impact at power plants on fish populations), 5:24024 (CONF-800543—2)
Population-level assessments should be emphasized over community/ecosystem-level assessments. Environmental Sciences Division Publication No. 1535, 5:24025 (CONF-800543—3)
MECHANICAL VIBRATIONS/MEASURING INSTRUMENTS
Study of the interactions between friction, wear and system rigidity. Progress report, July 1, 1979-June 30, 1980, 5:24509 (DOE/ER/10471—1)
MECHANICAL VIBRATIONS/POLLUTION ABATEMENT
Control of vibration and blast noise from surface coal mining. Volume I. Open file report (final) 1 July 1975-28 February 1978, 5:23519 (PB—299887)
Control of vibration and blast noise from surface coal mining. Volume II. Open file report (final) 1 July 1975-28 February 1978, 5:23520 (PB—299888)
Control of vibration and blast noise from surface coal mining. Volume III. Open file report (final) 1 July 1975-28 February 1978, 5:23521 (PB—299889)
MECHANICAL VIBRATIONS/POLLUTION CONTROL
Control of vibration and blast noise from surface coal mining. Volume IV. Executive report. Open file report (final) 1 July 1975-28 February 1978, 5:23522 (PB—299890)
MELTDOWN
See also CORIUM
MELTDOWN/AFTER-HEAT
Modeling decay heat-induced melting of a concrete slab by use of the general heat conduction code HEATING 5 (PWR; BWR), 5:24095 (ORNL/TM—7211)
MELTDOWN/HEAT TRANSFER
Growth of molten core debris pools in concrete. Part II. A. Pool growth in composite beds; B. Effect of overlaying steel layers. Final report, March 1, 1978-September 30, 1979 (LMFBR), 5:24090 (COO—4261-14)
MELTDOWN/HYDRAULICS
Assessment of molten debris freezing in a severe RIA in-pile test (PWR; BWR), 5:24088 (CONF-800607—15)
Growth of molten core debris pools in concrete. Part II. A. Pool growth in composite beds; B. Effect of overlaying steel layers. Final report, March 1, 1978-September 30, 1979 (LMFBR), 5:24090 (COO—4261-14)
MELTDOWN/TEMPERATURE GRADIENTS
Modeling decay heat-induced melting of a concrete slab by use of the general heat conduction code HEATING 5 (PWR; BWR), 5:24095 (ORNL/TM—7211)
MEMBRANE TRANSPORT/AGE DEPENDENCE
Oxygen effect and adaptive reactions of cells. Report 2. Kinetics of respiration of tumor cells differing in initial respiration level (γ rays; Ehrlich ascites tumor cells), 5:24747
MEMBRANE TRANSPORT/BIOASSAY
Incorporation of transport molecules into black lipid membranes, 5:24707
MEMBRANES
See also CELL MEMBRANES

MEMBRANES/MATERIALS TESTING
Technical and economic feasibility of membrane technology. Technical progress report, December 17, 1979-March 16, 1980, 5:23834 (BSDF—39-2Q-80)
MEMBRANES/PERMEABILITY
New technique for determining the parameters of gas permeation through solids, 5:24494 (GEPP-OP—474a)
MERCURY/ACTIVATION ANALYSIS
Activation analysis, 5:24485
Instrumental analysis of trace elements in thumbnails of human subjects, 5:24484
MERCURY CHLORIDES/BIOLOGICAL EFFECTS
Effects of divalent metal chlorides on respiration and extractable enzymatic activities of douglas-fir needle litter, 5:24769
MERCURY ISOTOPES/ENERGY LEVELS
Use of systematics in the interpretation of nuclear structure far from the beta-stable region, 5:24930 (CONF-790976—9)
MESON RESONANCES
See also CHARMED MESON RESONANCES
CHI RESONANCES
D RESONANCES
D-1865 RESONANCES
F-2030 RESONANCES
K-892 RESONANCES
PSI RESONANCES
PSI-3695 RESONANCES
RHO-765 RESONANCES
VECTOR MESONS
MESON RESONANCES/MASS
Investigation of higher-mass even-G states from 15-GeV/c π^+ d collisions, 5:24855
MESON RESONANCES/PARTICLE PRODUCTION
Investigation of higher-mass even-G states from 15-GeV/c π^+ d collisions, 5:24855
MESONS
See also MESON RESONANCES
MESONS/MULTIPLE PRODUCTION
Recombination model and multimeson production, 5:24869
MESSENGER-RNA/HYBRIDIZATION
Transcription of yeast mitochondrial deoxyribonucleic acid, 5:24684
METABOLIC DISEASES/DIAGNOSIS
Changes in plasma lipoprotein distribution and formation of two unusual particles after heparin-induced lipolysis in hypertriglyceridemic subjects, 5:24718
METABOLISM/AGE DEPENDENCE
Lead transfer in maternal milk, and the absorption, retention, distribution and excretion of lead in suckling mice, 5:24771 (UR—3490-1798)
METABOLITES/BIOLOGICAL EFFECTS
Reproductive survival and macromolecular synthesis in cultured mammalian cells exposed to single metabolites and mixtures of metabolites of benzo(a)pyrene, 5:24762 (CONF-791059—6)
METABOLITES/DECOMPOSITION
Aryl hydrocarbon hydroxylase: degradation of product due to contaminant in acetone, 5:24671
METAGALAXY
See UNIVERSE
METAL INDUSTRY/AIR POLLUTION CONTROL
Controlling pollution from the manufacturing and coating of metal products. 1. Metal coating air pollution control. Technology transfer report, 5:24603 (PB—299672)
Controlling pollution from the manufacturing and coating of metal products. 2. Solvent metal cleaning air pollution control. Technology transfer report, 5:24604 (PB—299673)
METAL INDUSTRY/ENERGY CONSERVATION
Potential for energy conservaton in the metal forming industries. Progress report, July 1, 1978-August 15, 1979, 5:24297 (COO—4930-1)
METAL INDUSTRY/HEAT RECOVERY EQUIPMENT
Potential industrial applications for fluidized-bed waste heat recovery systems, 5:24308 (DOE/CS/40255—1)
METAL INDUSTRY/INDUSTRIAL WASTES
Environmental and resource conservation considerations of steel industry solid waste. Final report May 1978-February 1979, 5:24315 (PB—299919)
METAL INDUSTRY/SOLAR PROCESS HEAT
Solar collector and industrial heat pump system for process hot water for an aluminum anodizing line, 5:23936 (SERI/TP—333-429)
METAL-METAL BATTERIES/PERFORMANCE
Electrochemical generator based upon molten fluorides (Na/Ni, Li-Al/Ni, Li-Al/FeS + graphite, Al/Ni with LiF-NaF-KF eutectic, 100 Wh/kg), 5:24105
METAL-METAL OXIDE BATTERIES
See also IRON-NICKEL BATTERIES
NICKEL-CADMIUM BATTERIES
NICKEL-ZINC BATTERIES
SILVER-ZINC BATTERIES
METAL-METAL OXIDE BATTERIES/PERFORMANCE
Silver-iron battery performance characteristics (Fe/KOH/AgO, 140 Ah), 5:24138
METAL-NONMETAL BATTERIES
See also LITHIUM-SULFUR BATTERIES
SODIUM-SULFUR BATTERIES
METAL-NONMETAL BATTERIES/BATTERY CHARGERS
System and method for charging electrochemical cells in series (Patent application), 5:24154
METAL-NONMETAL BATTERIES/PERFORMANCE
Electrochemical generator based upon molten fluorides (Na/Ni, Li-Al/Ni, Li-Al/FeS + graphite, Al/Ni with LiF-NaF-KF eutectic, 100 Wh/kg), 5:24105
METAL-NONMETAL BATTERIES/RESEARCH PROGRAMS
Development of advanced batteries at Argonne National Laboratory. Summary report for 1979 (Li-Al/LiCl-KCl/FeS or FeS_2, 40 kWh; also Ca-Si/FeS_2), 5:24103 (ANL—80-32)
METALS
See also ACTINIDES
LIQUID METALS
RARE EARTHS
REFRACTORY METALS
METALS/MATERIALS RECOVERY
A pollution-free system for the economic utilization of municipal solid waste, task 10, electrochemical recovery of non ferrous metals derived from municipal refuse, 5:24326 (PB—299753)
Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation. Volume II. working papers, 5:24329 (PB—300848)
Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation, 5:24330 (PB—300849)
METALS/PLASTICITY
Use of endochronic plasticity for multi-dimensional small and large strain problems, 5:24385 (ANL-CT—79-19)
METALS/PROTECTIVE COATINGS
Literature review of palliatives for fretting fatigue, 5:24418
METEORITES/CHEMICAL COMPOSITION
Silver isotopic anomalies in iron meteorites: cosmic-ray production and other possible sources, 5:24801 (LA-UR—80-1199)
METEORITES/ISOTOPE RATIO
Silver isotopic anomalies in iron meteorites: cosmic-ray production and other possible sources, 5:24801 (LA-UR—80-1199)
METEOROLOGY/BIOLOGICAL EFFECTS
Asthma and air pollution in the Los Angeles area. Technical report No. 35, 5:24776 (DOE/EV/02874—69)
METEOROLOGY/CORRELATIONS
Asthma and air pollution in the Los Angeles area. Technical report No. 35, 5:24776 (DOE/EV/02874—69)
METEOROLOGY/DATA ACQUISITION
Asthma and air pollution in the Los Angeles area. Technical report No. 35, 5:24776 (DOE/EV/02874—69)
METHACRYLIC ACID ESTERS/CHEMICAL RADIATION EFFECTS
process for coating a substrate with a radiation and moisture curable coating composition (Patent), 5:24503
METHANATION/CATALYSTS
Alloy catalysts with monolith supports for methanation of coal-derived gases. Quarterly technical progress report, June 21-September 20, 1979, 5:23425 (FE—2729-8)
METHANE/BIOSYNTHESIS
Anaerobic digestion of marine biomass, 5:23840
METHANE/IMPURITIES
Effect of container preparation on the growth of protium and methane impurities into tritium gas, 5:25095
METHANE/PRODUCTION
Self-disintegrating raney metal alloys (Patent), 5:24370
METHANE/SEPARATION PROCESSES
Effect of the degree of hydration of the adsorbent on the chromatographic analysis of common gases, 5:24493 (DP-TR—9)
METHANE/SUBLIMATION
Methane outgassing from a Ti sublimation pump, 5:24558
METHANE/VIBRATIONAL STATES
Vibration→vibration energy transfer in methane, 5:24822
METHANOL/CATALYTIC CRACKING
1 kW tungsten carbide fuel cell power plant with a methanol cracker, 5:24235
METHANOL/CHEMICAL PREPARATION
Catalyst for synthesis of methanol (Patent), 5:23774
METHANOL/CHEMICAL REACTIONS
Conversion of coal-based methanol to ethylene and a gaseous fuel. Final report 1 October 1975-30 September 1978, 5:23773 (PB—301256)

METHANOL/ISOTOPE EFFECTS
Critical test of vibrational dephasing theories in liquids by use of selective, coherent, picosecond Stokes scattering, 5:24476
METHEMOGLOBIN/CONFIGURATION INTERACTION
Quaternay structure and spin state of human fetal methemoglobin. Progress report, September 1, 1979-July 1, 1980, 5:24670 (DOE/EV/03221—65)
METHEMOGLOBIN/RADIOLYSIS
Chain inequivalence in bovine methemoglobin. Progress report, December 1, 1979-November 30, 1980, 5:24733 (DOE/EV/03221—61)
METHYL METHANESULFONATE/BIOLOGICAL EFFECTS
Analysis of the effects of chemical and physical mutagens on subchromosomal DNA synthesis in cultured mammalian cells (X rays; uv radiation; MMS), 5:24736 (UR—3490/LCP-20)
METHYL PHENOLS
See CRESOLS
MEXICO/AIR POLLUTION
The calculation of long period mean pollutant concentrations in an urban atmosphere. Part II. Simulation of annual sulfur dioxide concentrations in Mexico City, 5:24605 (PB—299726)
MFTF DEVICES/MAGNETIC FIELD REVERSAL
Estimation of neutral-beam-induced field reversal in MFTF by an approximate scaling law, 5:25051 (UCID—18615)
MFTF DEVICES/PLASMA DENSITY
Buildup studies for MFTF-B, 5:24981 (UCID—18334)
MHD CHANNELS/BREAKDOWN
Critical phenomena in MHD generators, 5:24227 (FE—2215-13(Vol.2))
MHD CHANNELS/FLOW MODELS
Critical phenomena in MHD generators, 5:24227 (FE—2215-13(Vol.2))
MHD generator modeling, 5:24228 (FE—2215-13(Vol.2))
MHD CHANNELS/MATERIALS TESTING
Electrode module development, 5:24225 (FE—2215-13(Vol.1))
MHD CHANNELS/PERFORMANCE TESTING
Joint US-USSR test of the US MHD electrode system in the U-02 facility, Phase III. Final report, 5:24221 (FE—2248-23)
MHD CHANNELS/TURBULENT FLOW
Critical phenomena in MHD generators, 5:24227 (FE—2215-13(Vol.2))
MHD GENERATOR U-02/COORDINATED RESEARCH PROGRAMS
Joint US-USSR test of the US MHD electrode system in the U-02 facility, Phase III. Final report, 5:24221 (FE—2248-23)
MHD GENERATOR U-02/PERFORMANCE TESTING
Joint US-USSR test of the US MHD electrode system in the U-02 facility, Phase III. Final report, 5:24221 (FE—2248-23)
MHD GENERATOR U-25/ELECTRODES
U-25 electrode development program, 5:24229 (FE—2215-13(Vol.2))
MHD GENERATORS
See also COAL-FIRED MHD GENERATORS
DISK MHD GENERATORS
MHD GENERATOR U-02
MHD GENERATOR U-25
MHD GENERATORS/FLOW MODELS
MHD generator modeling, 5:24228 (FE—2215-13(Vol.2))
MHD GENERATORS/INHOMOGENEOUS PLASMA
Critical phenomena in MHD generators, 5:24227 (FE—2215-13(Vol.2))
MHD GENERATORS/SUPERCONDUCTING MAGNETS
Superconducting magnet fabrication development, 5:24224 (FE—2215-13(Vol.1))
MHD GENERATORS/TEST FACILITIES
Electrode module development, 5:24225 (FE—2215-13(Vol.1))
MHD POWER PLANTS/ENVIRONMENTAL IMPACTS
Environmental readiness document magnetohydrodynamics, 5:24214 (DOE/EV/04651—T1)
MHD POWER PLANTS/OXYGEN ENRICHMENT
Optimization of air separation plants for combined cycle MHD-power plant applications, 5:24222 (DOE/NASA/2674—80/10)
MHD POWER PLANTS/PARAMETRIC ANALYSIS
Summary and evaluation of the parametric study of potential early commercial MHD power plants (PSPEC), 5:24218 (DOE/NASA/2674—80/9)
MICE/BIOLOGICAL RADIATION EFFECTS
Induction of lung tumors in RFM mice after localized exposures to x rays or neutrons, 5:24748
MICE/GENETIC RADIATION EFFECTS
Analysis of the albino-locus region of the mouse. III. Time of death of prenatal lethals, 5:24750
MICE/GENETICS
Genetic and developmental study of a complex locus in the house mouse. Progress report, August 1, 1978-June 1, 1979, 5:24709 (COO—4159-5)
MICELLAR-POLYMER FLOODING
See MICROEMULSION FLOODING
MICHIGAN/AUTOMOTIVE INDUSTRY
Coping with energy limitations in transportation: proposals for Michigan, 5:24179 (PB—299737)
MICHIGAN/DISTRICT COOLING
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume I. Text, 5:24322 (COO—4975-(Vol.1)(Text))
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume II. Appendices, 5:24325 (COO—4975-1(Vol.2)(App.))
MICHIGAN/DISTRICT HEATING
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume I. Text, 5:24322 (COO—4975-(Vol.1)(Text))
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume II. Appendices, 5:24325 (COO—4975-1(Vol.2)(App.))
MICHIGAN/GEOCHEMICAL SURVEYS
Hydrogeochemical and stream sediment reconnaissance basic data for Marquette NTMS Quadrangle, Michigan, 5:23693 (GJBX—106(80))
MICROANALYSIS/NSLS
Use of a synchrotron radiation x-ray microprobe for elemental analysis at the National Synchrotron Light Source, 5:24487 (BNL—27611)
MICROEMULSION FLOODING/RESEARCH PROGRAMS
Mechanism of oil bank formation, coalescence in porous media and emulsion stability. Annual report, June 1978-May 1979, 5:23575 (DOE/BC/10069—6)
MICROSCOPY
See also ELECTRON MICROSCOPY
ION MICROSCOPY
MICROSCOPY/DATA PROCESSING
Evaluation of an Automated Reflectance Microscope system for coal characterization. Technical report 18, 5:23454 (FE—2030-TR18)
MICROWAVE EQUIPMENT
See also SQUID DEVICES
MICROWAVE EQUIPMENT/SWITCHES
Optically coupled microwave switch, 5:24570 (SAND—80-0029C)
MILITARY FACILITIES/ENERGY CONSERVATION
Alternative power sources for air force terrestrial requirements, 5:24247
MILITARY FACILITIES/ENERGY DEMAND
Alternative power sources for air force terrestrial requirements, 5:24247
MILITARY FACILITIES/ENERGY SOURCES
Alternative power sources for air force terrestrial requirements, 5:24247
MILLET/GENETICS
Genetics of mutagen induced non-lethal chlorophyll mutants in pearl millet, 5:24715
MINE-MOUTH GENERATING PLANTS
See COAL MINES
FOSSIL-FUEL POWER PLANTS
MINING EQUIPMENT/IRON-NICKEL BATTERIES
Performance characteristics of iron nickel batteries (109 kWh, 132 V), 5:24136
MINI-SERVE STATIONS
See GASOLINE SERVICE STATIONS
MINNESOTA/CO-GENERATION
Feasibility of a large district heating-cogeneration system for the Minneapolis-St. Paul area, 5:24189 (CONF-7910156—2)
MINNESOTA/DISTRICT HEATING
District heating and cooling system for communities through power plant retrofit and distribution network. Final report, Phase I, 5:24323 (COO—4980-1)
District heating and cooling through power plant retrofit and distribution network. Final report. Phase 1, executive summary, 5:24324 (COO—4980-1(Exec.Summ.))
Feasibility of a large district heating-cogeneration system for the Minneapolis-St. Paul area, 5:24189 (CONF-7910156—2)
MINNESOTA/POLLUTION REGULATIONS
Evaluation of motor vehicle emissions inspection and maintenance programs in Minnesota. Final report, 5:24353 (PB—301162)
MIRROR FUSION TEST FACILITY
See MFTF DEVICES
MIRRORS (MAGNETIC)
See MAGNETIC MIRRORS
MISSILES/ELECTRIC POWER
Ram air turbine power supplies for high performance flight vehicles, 5:24339
MISSILES/ENERGY STORAGE SYSTEMS
Comparison of alternate power sources for the MX missile system, 5:24334
MISSILES/INVESTMENT
Shifting MX expenditures to energy efficiency: memo on the national security implications of alternative energy development, 5:24192 (CEP-OP—0-2)

MISSILES/NICKEL-ZINC BATTERIES
Development of nickel-zinc batteries for aircraft, remotely piloted vehicle and missile applications, 5:24137
MISSILES/SILVER-ZINC BATTERIES
Long-life rechargeable silver-zinc battery (12 V, 40 Ah), 5:24115
MISSILES/SPACECRAFT POWER SUPPLIES
Comparison of alternate power sources for the MX missile system, 5:24334
Ram air turbine power supplies for high performance flight vehicles, 5:24339
MISSISSIPPI/ELECTRIC UTILITIES
Analysis of environmental factors affecting technology deployment: a case study, 5:24027 (DOE/RA/10001—T1)
MITOGENS/BIOLOGICAL EFFECTS
Inhibition of cytotoxic T lymphocytes with concanavalin A, 5:24703
MOBILE HOMES/SOLAR SPACE HEATING
Performance of a packaged solar space-heating system used with a mobile home, 5:23890 (PB—300890)
MODELS (COSMOLOGICAL)
See COSMOLOGICAL MODELS
MODELS (CRYSTAL)
See CRYSTAL MODELS
MODELS (NUCLEAR)
See NUCLEAR MODELS
MODELS (PLASMA)
See PLASMA SIMULATION
MODELS (STAR)
See STAR MODELS
MODIFIED IN-SITU PROCESSES
See also OXY MODIFIED IN-SITU PROCESS
MODIFIED IN-SITU PROCESSES/ENVIRONMENTAL IMPACTS
Environmental assessment: DOE/Occidental Oil Shale, Inc. cooperative agreement, Phase II, oil shale retorting, Logan Wash Site, Garfield County, Colorado, 5:23659 (DOE/EA—0095)
MODIFIED IN-SITU PROCESSES/HEALTH HAZARDS
DOE/EV Task Force on the environmental and health effects of modified in situ oil shale processes, 5:23649
MOLDS
See FUNGI
MOLECULAR IONS/PHOTOIONIZATION
Complex-basis-function calculations of resolvent matrix elements: Molecular photoionization, 5:24829
MOLECULAR ORBITAL MODEL
See MOLECULES
MOLECULES/AUGER ELECTRON SPECTROSCOPY
Auger lineshape analysis of molecules and solids, 5:24965
MOLECULES/ELECTRONIC STRUCTURE
Auger lineshape analysis of molecules and solids, 5:24965
MOLLUSCS
See also OYSTERS
MOLLUSCS/MORTALITY
Examination of the effects of 50 ppB copper on the black abalone, Haliotis cracherodii, 5:24770 (UCRL—52932)
MOLTEN SALT COAL GASIFICATION PROCESS/PROCESS DEVELOPMENT UNITS
Molten Salt Coal Gasification Process Development Unit. Quarterly technical progress report No. 13, April-June 1979, 5:23429 (SAN—1429-52)
MOLYBDENUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
MOLYBDENUM/CATALYTIC EFFECTS
Hydroprocessing of hydrocarbons over nickel, moly, platinum catalyst (Patent), 5:23593
MOLYBDENUM/ETCHING
Pre-treatment for molybdenum or molybdenum-rich alloy articles to be plated (Patent), 5:24366
MOLYBDENUM 96 TARGET/TRITON REACTIONS
Search for nuclear structure dependence of analyzing powers for the (t,p) reaction in medium mass nuclei, 5:24917
MOLYBDENUM 98/ENERGY LEVELS
Search for nuclear structure dependence of analyzing powers for the (t,p) reaction in medium mass nuclei, 5:24917
MOLYBDENUM ALLOYS
See also MOLYBDENUM BASE ALLOYS
MOLYBDENUM ALLOYS/FABRICATION
Alloys for a liquid metal fast breeder reactor (Patent), 5:24372
MOLYBDENUM ALLOYS/PHYSICAL RADIATION EFFECTS
Swelling and phase instability in neutron irradiated compositional variants of alloy D9, 5:24420 (DOE/TIC—11202)
MOLYBDENUM ALLOYS/WELDED JOINTS
Delta ferrite-containing austenitic stainless steel resistant to the formation of undesirable phases upon aging (Patent), 5:24360
MOLYBDENUM BASE ALLOYS/ETCHING
Pre-treatment for molybdenum or molybdenum-rich alloy articles to be plated (Patent), 5:24366
MOLYBDENUM IONS/EMISSION SPECTRA
XUV spectra of Mo XIII-XVIII, 5:25002 (NRL-MR—4177)
MOLYBDENUM SILICIDES/BONDING
Silicon-nitride and metal composite (Patent), 5:24427
MOLYBDENUM SILICIDES/CORROSION RESISTANCE
Silicon-nitride and metal composite (Patent), 5:24427
MOLYBDENUM SULFIDES/SURFACE COATING
Dispersion of life of bonded MoS2 solid lubricant coatings, 5:24391
MOLYBDENUM SULFIDES/WEAR
Dispersion of life of bonded MoS2 solid lubricant coatings, 5:24391
MONTANA/COAL MINES
Evaluation of the environmental effects of western surface coal mining. Volume II. Mine inventory. Final report, 5:23529 (PB—301249)
MONTANA/GEOCHEMICAL SURVEYS
Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States, 5:23697 (LA-UR—80-1013)
MONTANA/SURFACE MINING
Strip coal mining and mined-land reclamation in the hydrologic system, southeastern Montana. Project completion report, 5:23530 (PB—301253)
MOORINGS/DESIGN
Preliminary designs for OTEC Stationkeeping Subsystems (SKSS). Summary report, 5:23868 (DOE/NOAA/OTEC—29(Summ.))
MORTARS/TESTING
Accelerated sulfate testing of mortars containing fly ash as a partial replacement for portland cement, 5:23487 (METC/SP—79/10(Pt.2))
MULE DEER
See DEER
MUNICIPAL WASTES/RECYCLING
A pollution-free system for the economic utilization of municipal solid waste, task 10, electrochemical recovery of non ferrous metals derived from municipal refuse, 5:24326 (PB—299753)
A pollution-free system for the economic utilization of municipal solid waste for the city of new york. phase i. a critical assessment of advanced technology. I. Thermal oxidation processes. II. Biochemical conversion processes. III. Refuse collection technology. IV. Reclamation and recycling, 5:24327 (PB—300465)
Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation. Volume II. working papers, 5:24329 (PB—300848)
Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation, 5:24330 (PB—300849)
Refractory particles in cullet recovered from municipal refuse. Technical report, 5:24328 (PB—300523)
MUNICIPAL WASTES/WASTE DISPOSAL
A pollution-free system for the economic utilization of municipal solid waste for the city of new york. phase i. a critical assessment of advanced technology. I. Thermal oxidation processes. II. Biochemical conversion processes. III. Refuse collection technology. IV. Reclamation and recycling, 5:24327 (PB—300465)
MUNICIPAL WASTES/WASTE PROCESSING
A pollution-free system for the economic utilization of municipal solid waste for the city of new york. phase i. a critical assessment of advanced technology. I. Thermal oxidation processes. II. Biochemical conversion processes. III. Refuse collection technology. IV. Reclamation and recycling, 5:24327 (PB—300465)
MUON REACTIONS/BREAKUP REACTIONS
Nuclear disintegration of some complex nuclei by 60-MeV muons, 5:24899
MUON REACTIONS/CAPTURE
Actinide muonic atom lifetimes deduced from muon-induced fission, 5:24937
MUON REACTIONS/FISSION
Actinide muonic atom lifetimes deduced from muon-induced fission, 5:24937
MUONIC ATOMS/LIFETIME
Actinide muonic atom lifetimes deduced from muon-induced fission, 5:24937
MUONIC ATOMS/X-RAY SPECTRA
X-ray yields in protonium and mesic hydrogen, 5:24818
MUSCLES/CHEMICAL ANALYSIS
Muscle protein analysis. I. High-resolution two-dimensional electrophoresis of skeletal muscle proteins for analysis of small biopsy samples, 5:24676

MUSSELS
See MOLLUSCS
MUTAGEN SCREENING/BIOLOGICAL INDICATORS
Screening for mutagenic response of six coded chemicals in the CHO/HGPRT system, 5:24763 (CONF-7910146—1)
MUTAGENESIS/PHOTOSENSITIVITY
Photodynamic effects of dyes on bacteria. I. Mutagenesis by acridine orange in the dark in excision- and recombination-deficient strains of Escherichia coli, 5:24766
MUTAGENESIS/RADIOINDUCTION
Mutagenicity and cytotoxicity of 4.4-MeV α particles emitted by plutonium-238, 5:24739
MUTANTS/BIOASSAY
Unstable, non-mutational expression of resistance to the thymidine analogue, trifluorothymidine in CHO cells, 5:24764
MX DEVICES
See MFTF DEVICES
MYOSIN/ELECTROPHORESIS
Muscle protein analysis. I. High-resolution two-dimensional electrophoresis of skeletal muscle proteins for analysis of small biopsy samples, 5:24676

N

NAGASAKI/NUCLEAR EXPLOSIONS
Numerical simulation of self-induced rainout using a dynamic convective cloud model, 5:24635 (UCRL—83583)
NAILS/ACTIVATION ANALYSIS
Instrumental analysis of trace elements in thumbnails of human subjects, 5:24484
NAPHTHA/CATALYTIC REFORMING
High severity process for the production of aromatic hydrocarbons (Patent), 5:23598
NATIONAL GOVERNMENT/ENERGY CONSERVATION
Energy management in the Federal Government, 5:24174 (DOE/S—0005(79))
NATIONAL GOVERNMENT/ENERGY POLICY
Energy policy and research planning. Volume 3. October, 1977-September, 1979 (a bibliography with abstracts). Report for October 1977-September 1979, 5:24205 (NTIS/PS—79/1069)
NATIONAL GOVERNMENT/VEHICLES
Energy management in the Federal Government, 5:24174 (DOE/S—0005(79))
NATIONAL SECURITY/COMPARATIVE EVALUATIONS
Shifting MX expenditures to energy efficiency: memo on the national security implications of alternative energy development, 5:24192 (CEP-OP—0-2)
NATIONAL SYNCHROTRON LIGHT SOURCE
See NSLS
NATURAL GAS
See also LIQUEFIED NATURAL GAS
NATURAL GAS/BY-PRODUCTS
Changing patterns in world nitrogen fertilizer production and trade, 5:24209 (UCID—18621)
NATURAL GAS/DESULFURIZATION
Process for alternately steam reforming sulfur containing hydrocarbons that vary in oxygen content (Patent), 5:23610
NATURAL GAS/FUEL CONSUMPTION
Historic and projected oil and gas consumption, 5:23605
NATURAL GAS/TRADE
Changing patterns in world nitrogen fertilizer production and trade, 5:24209 (UCID—18621)
NATURAL GAS DEPOSITS/GEOLOGIC STRUCTURES
Michigan's Silurian oil and gas pools. Report of investigation 2, 5:23574
NATURAL GAS DEPOSITS/LEASING
Alaska OCS socioeconomic studies program. Technical report No. 43. Lower Cook Inlet and Shelikof Strait petroleum development scenarios. Final report, 5:23604 (PB—300701)
Modeling the number of bids received on federal offshore hydrocarbon leases by poisson-type models, 5:23601 (LA—8347-MS)
NATURAL GAS DEPOSITS/OFFSHORE OPERATIONS
Outer continental shelf environmental monitoring concerns. Final report, 5:23607 (PB—299861)
NATURAL GAS DEPOSITS/RESOURCE POTENTIAL
Limiting behavior of sampling proportional to random size, 5:23572 (CONF-791241—1)
NATURAL GAS DISTRIBUTION SYSTEMS/SAFETY ENGINEERING
Natural gas pipeline safety in residential areas served by master meters. a handbook, 5:23611 (PB—300118)
NATURAL GAS GATHERING SYSTEMS
See NATURAL GAS DISTRIBUTION SYSTEMS
NATURAL GAS INDUSTRY/ECONOMIC IMPACT
Alaska OCS socioeconomic studies program. Technical report No. 43. Lower Cook Inlet and Shelikof Strait petroleum development scenarios. Final report, 5:23604 (PB—300701)
NATURAL GAS INDUSTRY/ENVIRONMENTAL IMPACTS
Gas industry and the environment, 5:23613
NATURAL GAS INDUSTRY/FINANCIAL INCENTIVES
Analysis of federal incentives used to stimulate energy production: an executive summary, 5:24182 (PNL—2410(Rev.2))
NATURAL GAS INDUSTRY/MEETINGS
Gas industry and the environment, 5:23613
NATURAL GAS INDUSTRY/SOCIAL IMPACT
Alaska OCS socioeconomic studies program. Technical report No. 43. Lower Cook Inlet and Shelikof Strait petroleum development scenarios. Final report, 5:23604 (PB—300701)
NATURAL GAS WELLS/RADIOACTIVE TRACER LOGGING
Method for monioring fluid movement behind casing in oil and gas wells (Patent), 5:23586
NATURAL RUBBER/CONSUMPTION RATES
Industrial recovered-materials-utilization targets for the rubber industry. Final report, 5:24319 (SAN—1701-T1)
NATURAL STEAM
(Use for geothermal steam that contains incondensible gases (typically CO_2 and H_2S) with minor amounts of other gases.)
NATURAL STEAM/REMOVAL
Process for purifying geothermal steam (Patent), 5:23992
NAVIGATIONAL INSTRUMENTS/PERFORMANCE
The effects of primary power transmission lines on the performance of LORAN-C receivers in experimental terrestrial applications. Final report May-July 1979, 5:24040 (PB—301367)
NAVIGATIONAL INSTRUMENTS/RADIO NOISE
The effects of primary power transmission lines on the performance of LORAN-C receivers in experimental terrestrial applications. Final report May-July 1979, 5:24040 (PB—301367)
NEODYMIUM 150 TARGET/OXYGEN 18 REACTIONS
High-spin properties of ^{164}Er in the multiple band crossing region, 5:24922
NEOMYCIN
See ANTIBIOTICS
NEON 20 REACTIONS/COMPOUND-NUCLEUS REACTIONS
Exactly central heavy-ion collisions by nuclear hydrodynamics, 5:24928
NEON 20 REACTIONS/SPALLATION
Target residues from the reaction of 8 GeV ^{20}Ne with ^{181}Ta and ^{197}Au, 5:24926
NEON 20 TARGET/CARBON 12 REACTIONS
Complete fusion of ^{12}C with ^{20}Ne, 5:24907
NEON 21/HIGH SPIN STATES
^{12}C(^{13}C, α)^{21}Ne reaction. High-spin states, resonances and coherence widths, 5:24900
NEON IONS/ION DOSIMETRY
Energy deposition in nanometer regions by 377 MeV/nucleon ^{20}Ne ions, 5:24723
NEON IONS/TRANSMISSION
Experimental limits on deviations from Z^2 dependence of Cerenkov radiation by heavy ions, 5:24950
NEOPLASMS
See also ADENOMAS
CARCINOMAS
NEOPLASMS/RADIOINDUCTION
Induction of lung tumors in RFM mice after localized exposures to x rays or neutrons, 5:24748
NEPTUNIUM/MUONIC ATOMS
Actinide muonic atom lifetimes deduced from muon-induced fission, 5:24937
NEPTUNIUM 237 TARGET/MUON REACTIONS
Actinide muonic atom lifetimes deduced from muon-induced fission, 5:24937
NETWORK ANALYSIS/ALGORITHMS
Generation of approximating distributions through the method of stages, 5:25104 (BNL—27513)
NETWORKS (COMPUTER)
See COMPUTER NETWORKS
NEUTRAL BEAM SOURCES
See also ION SOURCES
NEUTRAL BEAM SOURCES/CALORIMETERS
Calorimeter for pulsed energy sources, 5:25086 (CONF-791102—165)
NEUTRAL BEAM SOURCES/CRYOPUMPS
Direct cryosorption pumping of an energetic hydrogen ion beam, 5:25087 (CONF-791102—171)
NEUTRAL BEAM SOURCES/SHIELDING
Shielding of fusion reactors, 5:25085 (CONF-791058—75)
NEUTRINO-ELECTRON INTERACTIONS/CROSS SECTIONS
Measurement of the cross section for ν/sub μ/ + e^- → ν/sub μ/ + e^-, 5:24848
NEUTRINOS/PARTICLE PRODUCTION
Background to neutrino counting in e^+e^- collisions, 5:24859

NEUTRON REACTIONS/CAPTURE
Energy dependence of the ^{238}U thermal capture cross section (25 to 450°C), 5:24936 (DP-MS—79-106)
Evidence for an E2 resonance observed by radiative capture of fast neutrons by ^{40}Ca (6 to 13 MeV), 5:24912
Level structure of ^{196}Pt, 5:24932
NEUTRON REACTIONS/COMPOUND-NUCLEUS REACTIONS
Levels of ^{230}Ac and ^{230}Th populated by decay of ^{230}Ra and ^{230}Ac, 5:24935
NEUTRON REACTIONS/ELASTIC SCATTERING
Neutron total cross section of sulfur: Single level to multilevel to optical model, 5:24902
NEUTRON REACTIONS/RESONANCE SCATTERING
Photoneutron studies of E1, M1, and E2 excitations in ^{13}C, 5:24897
NEUTRON SOURCES
(Excludes reactors even when used as neutron sources.)
NEUTRON SOURCES/NEUTRON LEAKAGE
Slow neutron leakage spectra from spallation neutron sources, 5:24952 (ANL—80-27)
NEUTRON THERAPY/SIDE EFFECTS
Induction of lung tumors in RFM mice after localized exposures to x rays or neutrons, 5:24748
NEUTRON-DEFICIENT ISOTOPES/NUCLEAR STRUCTURE
Use of systematics in the interpretation of nuclear structure far from the beta-stable region, 5:24930 (CONF-790976—9)
NEUTRON-RICH ISOTOPES/NUCLEAR STRUCTURE
Use of systematics in the interpretation of nuclear structure far from the beta-stable region, 5:24930 (CONF-790976—9)
NEVADA/GEOTHERMAL RESOURCES
Nevada geothermal commercialization planning. Quarterly progress report, January 1, 1980-March 31, 1980, 5:23980 (DOE/RA/50076—T1)
Nevada geothermal commercialization planning. Semi-annual progress report, January 1, 1979-June 30, 1979, 5:23990 (DOE/ID/12019—1)
NEVADA/RESOURCE DEVELOPMENT
Nevada geothermal commercialization planning. Quarterly progress report, January 1, 1980-March 31, 1980, 5:23980 (DOE/RA/50076—T1)
NEVADA TEST SITE/RADIATION MONITORING
Offsite environmental monitoring report for the Nevada Test Site and other test areas used for underground nuclear detonations, January-December 1979, 5:24630 (EMSL-LV—0539-36)
NEVADA TEST SITE/SOILS
Soil profiles of mounds on plutonium-contaminated areas of the Nevada Test Range Complex, 5:24641 (EMSL-LV—0539-33)
NEVADA TEST SITE/UNDERGROUND EXPLOSIONS
Prediction of ground motion from underground nuclear weapons tests as it relates to siting of a nuclear waste storage facility at NTS and compatibility with the weapons test program, 5:23745 (SAND—80-1020/1)
Prediction of ground motion from underground nuclear weapons tests as it relates to siting of a nuclear waste storage facility at NTS and compatibility with the weapons test program, 5:23746 (SAND—80-1020/1)
NEW MEXICO/COAL MINES
Evaluation of the environmental effects of western surface coal mining. Volume II. Mine inventory. Final report, 5:23529 (PB—301249)
NEW MEXICO/GEOCHEMICAL SURVEYS
Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States, 5:23697 (LA-UR—80-1013)
NEW MEXICO/GEOLOGY
In-progress geologic map of Canon de San Diego, Jemez Springs, New Mexico, and lithologic log of Jemez Springs geothermal well, 5:23984 (LA—8276-MAP)
NEW MEXICO/GEOTHERMAL RESOURCES
Geothermal investigation of spring and well waters of the Los Alamos Region, New Mexico, 5:23986 (LA—8326-MS)
NEW MEXICO/GEOTHERMAL WELLS
In-progress geologic map of Canon de San Diego, Jemez Springs, New Mexico, and lithologic log of Jemez Springs geothermal well, 5:23984 (LA—8276-MAP)
NEW MEXICO/HYDROTHERMAL SYSTEMS
Impacts of deep geothermal fluid production on shallow groundwater systems, 5:23983 (CONF-7910155—1)
NEW MEXICO/MAPS
In-progress geologic map of Canon de San Diego, Jemez Springs, New Mexico, and lithologic log of Jemez Springs geothermal well, 5:23984 (LA—8276-MAP)
NEW MEXICO/WATER RESOURCES
State policies and requirements for management of uranium mining and milling in New Mexico. Volume II. Water availability in the San Juan Structural Basin, 5:23754 (SAND—78-1331)
NEW YORK/AIR POLLUTION CONTROL
Impact of air quality control measures, 5:24640 (PB—301234)
NEW YORK/GEOLOGICAL SURVEYS
Isopach map of black shale in the Sonyea Group (from well sample studies), 5:23618 (METC/EGSP—108)
NEW YORK/WASTE MANAGEMENT
A pollution-free system for the economic utilization of municipal solid waste for the city of new york. phase i. a critical assessment of advanced technology. I. Thermal oxidation processes. II. Biochemical conversion processes. III. Refuse collection technology. IV. Reclamation and recycling, 5:24327 (PB—300465)
NICKEL/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
NICKEL/CATALYTIC EFFECTS
Alloy catalysts with monolith supports for methanation of coal-derived gases. Quarterly technical progress report, June 21-September 20, 1979, 5:23425 (FE—2729-8)
Hydroprocessing of hydrocarbons over nickel, moly, platinum catalyst (Patent), 5:23593
NICKEL/ION COLLISIONS
Azimuthal anisotropies of dimer ions ejected from ion bombarded Ni(001), 5:24807
NICKEL/OXIDATION
Surface oxidation of nickel metal as studied by x-ray photoelectron spectroscopy, 5:24419
NICKEL/PHYSICAL RADIATION EFFECTS
Experimental observations of effects of inert gas on cavity formation during irradiation, 5:24423 (ORNL/TM—7193)
NICKEL/SURFACE COATING
Corrosion behavior of lean uranium-titanium alloys, 5:24414 (SAND—80-8215)
NICKEL 56/ALPHA DECAY
Decay of deformed and superdeformed nuclei formed in heavy ion reactions, 5:24910
NICKEL 58 TARGET/MUON REACTIONS
Nuclear disintegration of some complex nuclei by 60-MeV muons, 5:24899
NICKEL ALLOYS
See also NICKEL BASE ALLOYS
NICKEL-CHROMIUM STEELS
NICKEL ALLOYS/CASTING
Fe-based long range ordered alloys (Patent), 5:24363
NICKEL ALLOYS/DECOMPOSITION
Self-disintegrating raney metal alloys (Patent), 5:24370
NICKEL ALLOYS/FABRICATION
Alloys for a liquid metal fast breeder reactor (Patent), 5:24372
Self-disintegrating raney metal alloys (Patent), 5:24370
NICKEL ALLOYS/GAS METAL-ARC WELDING
Weldability of thermally grain-refined Fe-12Ni-0.25Ti for cryogenic structural applications, 5:24369 (LBL—10259)
NICKEL ALLOYS/ORDER PARAMETERS
Fe-based long range ordered alloys (Patent), 5:24363
NICKEL ALLOYS/PHYSICAL RADIATION EFFECTS
Relationship between swelling and the shear modulus of irradiated metal, 5:24421 (HEDL-SA—1774-FP)
Swelling and phase instability in neutron irradiated compositional variants of alloy D9, 5:24420 (DOE/TIC—11202)
NICKEL ALLOYS/SORPTIVE PROPERTIES
HVEM in situ hydriding of hydrogen storage materials, 5:24394 (CONF-791132—5)
NICKEL ALLOYS/SWELLING
Relationship between swelling and the shear modulus of irradiated metal, 5:24421 (HEDL-SA—1774-FP)
NICKEL ALLOYS/WELDED JOINTS
Delta ferrite-containing austenitic stainless steel resistant to the formation of undesirable phases upon aging (Patent), 5:24360
Weldability of thermally grain-refined Fe-12Ni-0.25Ti for cryogenic structural applications, 5:24369 (LBL—10259)
NICKEL BASE ALLOYS
See also RENE-100
NICKEL BASE ALLOYS/CORROSION
Nickel-iron alloy corrosion in a sealed pyrotechnic system, 5:24413 (MLM—2707(OP))
NICKEL BASE ALLOYS/CREEP
Creep-rupture in powder metallurgical nickel-base superalloys at intermediate temperatures, 5:24389
NICKEL BASE ALLOYS/HOT PRESSING
Process for treating weldments (Patent), 5:24365
NICKEL BASE ALLOYS/RUPTURES
Creep-rupture in powder metallurgical nickel-base superalloys at intermediate temperatures, 5:24389
NICKEL BASE ALLOYS/WELDED JOINTS
Process for treating weldments (Patent), 5:24365
NICKEL CHLORIDES/BIOLOGICAL EFFECTS
Effects of divalent metal chlorides on respiration and extractable enzymatic activities of douglas-fir needle litter, 5:24769

NICKEL PHOSPHIDES/SURFACE COATING
Pre-treatment for molybdenum or molybdenum-rich alloy articles to be plated (Patent), 5:24366
NICKEL-CADMIUM BATTERIES/BATTERY SEPARATORS
Performance of nickel-cadmium satellite cells having new electrochemically impregnated, sintered electrodes (50 Ah (nominal)), 5:24134
NICKEL-CADMIUM BATTERIES/CATHODES
Considerations of capacity increases in sintered plate nickel oxide electrodes, 5:24133
NICKEL-CADMIUM BATTERIES/COMPUTER-AIDED DESIGN
Sealed nickel cadmium cell design by computer modeling, 5:24111
NICKEL-CADMIUM BATTERIES/ELECTROCHEMISTRY
Considerations of capacity increases in sintered plate nickel oxide electrodes, 5:24133
NICKEL-CADMIUM BATTERIES/FAILURES
Failure analysis of cells in an accelerated test program (6 Ah), 5:24131
NICKEL-CADMIUM BATTERIES/GASES
Aircraft accident report - Champion Home Builders Company, Gates Learjet 25B, N999HG, Sanford, North Carolina, September 8, 1977, 5:24123 (NTISUB/E—104-015)
NICKEL-CADMIUM BATTERIES/MAINTENANCE
Batteries for auxiliary electrical supplies in aircraft, 5:24172
NICKEL-CADMIUM BATTERIES/PERFORMANCE
INTELSAT IV Ni-Cd battery orbital performance (21 Ah), 5:24132
Long life lightweight nickel-cadmium battery development (22.5 Wh/kg, 1200 W), 5:24110
NICKEL-CADMIUM BATTERIES/PERFORMANCE TESTING
Performance of nickel-cadmium satellite cells having new electrochemically impregnated, sintered electrodes (50 Ah (nominal)), 5:24134
NICKEL-CADMIUM BATTERIES/SAFETY
Aircraft accident report - Champion Home Builders Company, Gates Learjet 25B, N999HG, Sanford, North Carolina, September 8, 1977, 5:24123 (NTISUB/E—104-015)
NICKEL-CHROMIUM STEELS
(Steels containing Ni and Cr; the Cr content is usually 0.5 to 2.0%, the Ni content is higher.)
NICKEL-CHROMIUM STEELS/FRACTURE PROPERTIES
Structure-property relations and the design of Fe-4Cr-C base structural steels for high strength and toughness, 5:24378
NICKEL-CHROMIUM STEELS/MICROSTRUCTURE
Structure-property relations and the design of Fe-4Cr-C base structural steels for high strength and toughness, 5:24378
NICKEL-HYDROGEN BATTERIES/ANODES
$LaNi_5$ electrodes in nickel-hydrogen batteries, 5:24164
NICKEL-HYDROGEN BATTERIES/CATHODES
Considerations of capacity increases in sintered plate nickel oxide electrodes, 5:24133
NICKEL-HYDROGEN BATTERIES/DESIGN
Design of long life nickel hydrogen cells (52 Ah), 5:24112
NICKEL-HYDROGEN BATTERIES/ELECTROCHEMISTRY
Considerations of capacity increases in sintered plate nickel oxide electrodes, 5:24133
NICKEL-HYDROGEN BATTERIES/PERFORMANCE TESTING
Improvement and cycle testing of Ni/H_2 cells (14 Ah), 5:24135
NICKEL-HYDROGEN BATTERIES/TESTING
Design of long life nickel hydrogen cells (52 Ah), 5:24112
NICKEL-ZINC BATTERIES/BATTERY SEPARATORS
Heat and chemically resistant membranes (Polyphenylquinoxaline + polar organic polymer), 5:24166
NICKEL-ZINC BATTERIES/PERFORMANCE TESTING
Development of nickel-zinc batteries for aircraft, remotely piloted vehicle and missile applications, 5:24137
NIMONIC PE16/PHYSICAL RADIATION EFFECTS
Experimental observations of effects of inert gas on cavity formation during irradiation, 5:24423 (ORNL/TM—7193)
NIOBIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
NIOBIUM/CHEMICAL BONDS
Photoemission studies of hydrogen chemisorption on Nb, 5:24399
NIOBIUM/CHEMISORPTION
Photoemission studies of hydrogen chemisorption on Nb, 5:24399
NIOBIUM/ELECTRONIC STRUCTURE
Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
NIOBIUM/ENERGY LEVELS
Photoemission studies of hydrogen chemisorption on Nb, 5:24399
NIOBIUM/ENERGY-LEVEL TRANSITIONS
Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
NIOBIUM/EXPLOSION WELDING
Viscosity of metals in explosive welding, 5:24371 (UCRL-Trans—11542)
NIOBIUM/FLEXIBILITY
Method of manufacturing a niobium-aluminum-germanium superconductive material (Patent), 5:24362
NIOBIUM/ION IMPLANTATION
Method of manufacturing a niobium-aluminum-germanium superconductive material (Patent), 5:24362
NIOBIUM/PHOTOELECTRON SPECTROSCOPY
Kinetics of two-state chemisorption: Hydrogen on niobium, 5:24400
Photoemission studies of hydrogen chemisorption on Nb, 5:24399
NIOBIUM/REFLECTIVITY
Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
NIOBIUM/SORPTIVE PROPERTIES
Kinetics of two-state chemisorption: Hydrogen on niobium, 5:24400
NIOBIUM ALLOYS
See also NIOBIUM BASE ALLOYS
NIOBIUM ALLOYS/CRITICAL CURRENT
Prediction of the stress state in Nb_3Sn superconducting composites, 5:24397
NIOBIUM ALLOYS/MAGNETIZATION
Paramagnetic properties of mixed-matrix NbTi conductors, 5:24513 (CONF-791102—169)
NIOBIUM ALLOYS/STRAINS
Effect of strain upon the scaling law for flux pinning in bronze process Nb_3Sn, 5:24404
NIOBIUM ALLOYS/SUPERCONDUCTIVITY
Effect of strain upon the scaling law for flux pinning in bronze process Nb_3Sn, 5:24404
NIOBIUM BASE ALLOYS/SUPERCONDUCTIVITY
LASL Nb_3Ge conductor development. Fourteenth quarterly progress report, October 1-December 31, 1979, 5:24969 (LA—8320-PR)
NIOBIUM CARBIDES/PHYSICAL RADIATION EFFECTS
Effect of neutron irradiation upon the superconducting critical temperature of some transition-metal carbides, nitrides, and carbonitrides, 5:24434
NIOBIUM CARBIDES/SUPERCONDUCTIVITY
Effect of neutron irradiation upon the superconducting critical temperature of some transition-metal carbides, nitrides, and carbonitrides, 5:24434
NIOBIUM COMPOUNDS/PHYSICAL RADIATION EFFECTS
Effect of neutron irradiation upon the superconducting critical temperature of some transition-metal carbides, nitrides, and carbonitrides, 5:24434
NIOBIUM COMPOUNDS/SUPERCONDUCTIVITY
Effect of neutron irradiation upon the superconducting critical temperature of some transition-metal carbides, nitrides, and carbonitrides, 5:24434
NIOBIUM NITRIDES/PHYSICAL RADIATION EFFECTS
Effect of neutron irradiation upon the superconducting critical temperature of some transition-metal carbides, nitrides, and carbonitrides, 5:24434
NIOBIUM NITRIDES/SUPERCONDUCTIVITY
Effect of neutron irradiation upon the superconducting critical temperature of some transition-metal carbides, nitrides, and carbonitrides, 5:24434
NIOBIUM OXIDES/PRODUCTION
Glass-ceramics for lightning arrestor connector seals, 5:24429 (SAND—80-0215)
NITRATES/BIOLOGICAL EFFECTS
Plant developmental system to measure the impact of pollutants in rain water, 5:24768
NITRIDES/SURFACE COATING
Chemical vapor deposition of sialon (Patent), 5:24425
NITRO COMPOUNDS
See also TNT
NITRO COMPOUNDS/ABSORPTION SPECTRA
Interactions of 4-nitroquinoline 1-oxide with deoxyribodinucleotides, 5:24679
NITRO COMPOUNDS/NMR SPECTRA
Interactions of 4-nitroquinoline 1-oxide with deoxyribodinucleotides, 5:24679
NITROGEN/FLAMES
Multiplicity and stability of nonadiabatic hydrogen-oxygen-nitrogen flames, 5:23770
NITROGEN/SEPARATION PROCESSES
Effect of the degree of hydration of the adsorbent on the chromatographic analysis of common gases, 5:24493 (DP-TR—9)
NITROGEN 14 TARGET/PION REACTIONS
Pion absorption processes (32 to 74 MeV), 5:24896 (COO—3244-72)

NITROGEN 15 REACTIONS/ELASTIC SCATTERING
Complete fusion of $^{15}N + ^{27}Al$, 5:24906
NITROGEN 15 REACTIONS/FUSION REACTIONS
Complete fusion of $^{15}N + ^{27}Al$, 5:24906
NITROGEN ADDITIONS/METALLURGICAL EFFECTS
Delta ferrite-containing austenitic stainless steel resistant to the formation of undesirable phases upon aging (Patent), 5:24360
NITROGEN CYCLE/SEASONAL VARIATIONS
Nitrogen fixation in Clear Lake, California. 4. Diel studies on Aphanizomenon and Anabaena blooms, 5:24689
NITROGEN DIOXIDE/AEROSOL MONITORING
Nitrogen oxide air pollution. Part 2. Detection and analysis. Volume2. 1976-August, 1979 (a bibliography with abstracts). Report for 1976-August 1979, 5:24595 (NTIS/PS—79/1058)
NITROGEN DIOXIDE/AIR POLLUTION CONTROL
Nitrogen oxide air pollution. Part 1. Control technology. volume 2. 1975-1977 (a bibliography with abstracts). Report for 1975-77, 5:24545 (NTIS/PS—79/1056)
Nitrogen oxide air pollution. Part 1. Control technology. Volume 3, 1978-August, 1979 (a bibliography with abstracts). Report for 1978-August 1979, 5:24546 (NTIS/PS—79/1057)
NITROGEN DIOXIDE/ATMOSPHERIC CHEMISTRY
Nitrogen oxide air pollution. part 3. atmospheric chemistry (a bibliography with abstracts). Report for 1964-August 1979, 5:24596 (NTIS/PS—79/1059)
NITROGEN DIOXIDE/BIBLIOGRAPHIES
Nitrogen oxide air pollution. Part 1. Control technology. volume 2. 1975-1977 (a bibliography with abstracts). Report for 1975-77, 5:24545 (NTIS/PS—79/1056)
Nitrogen oxide air pollution. Part 1. Control technology. Volume 3, 1978-August, 1979 (a bibliography with abstracts). Report for 1978-August 1979, 5:24546 (NTIS/PS—79/1057)
Nitrogen oxide air pollution. Part 2. Detection and analysis. Volume2. 1976-August, 1979 (a bibliography with abstracts). Report for 1976-August 1979, 5:24595 (NTIS/PS—79/1058)
NITROGEN DIOXIDE/BIOLOGICAL EFFECTS
Nitrogen oxide air pollution. part 4. Biological effects (a bibliograhy with abstracts). Report for 1964-August 1979, 5:24777 (NTIS/PS—79/1060)
NITROGEN DIOXIDE/EMISSION
Nitrogen oxide air pollution. Part 5. Emissions studies. Volume 2. 1975-1977 (a bibliography with abstracts). Report for 1975-77, 5:24597 (NTIS/PS—79/1061)
Nitrogen oxide air pollution. Part 5. Emissions studies. Volume 3. 1978-August, 1979 (a bibliography with abstracts). Report for 1975-August 1979, 5:24598 (NTIS/PS—79/1062)
NITROGEN DIOXIDE/HEALTH HAZARDS
Nitrogen oxide air pollution. part 4. Biological effects (a bibliograhy with abstracts). Report for 1964-August 1979, 5:24777 (NTIS/PS—79/1060)
NITROGEN IONS/ION-ATOM COLLISIONS
Electron-capture collisions at keV energies of boron and other multiply charged ions with atoms and molecules. II. Atomic hydrogen, 5:24824
NITROGEN OXIDES
See also NITROGEN DIOXIDE
NITROGEN OXIDES/AIR POLLUTION ABATEMENT
Performance of a diesel engine operating on raw coal-diesel fuel and solvent refined coal-diesel fuel slurries. Final report, 5:24335 (CONS—3288-T6)
NITROGEN OXIDES/AIR POLLUTION CONTROL
Durability testing at 5 atmospheres of advanced catalysts and catalyst supports for gas turbine engine combustors, 5:24338 (DOE/NASA/9416—80/2)
Effectiveness and cost of air pollution control for coal-fired electric power plants in the west, 5:24037 (PB—300515)
Environmental assessment of stationary source NOx control technologies. Annual report no. 2, June 1977-June 1978, 5:24547 (PB—300469)
Evaluation of motor vehicle emissions inspection and maintenance programs in Minnesota. Final report, 5:24353 (PB—301162)
Impact of ammonia utilization by NOx flue gas treatment processes. Final report August 1977-November 1978, 5:24038 (PB—300596)
NITROGEN OXIDES/ATMOSPHERIC CHEMISTRY
Nitrogen oxide air pollution. part 3. atmospheric chemistry (a bibliography with abstracts). Report for 1964-August 1979, 5:24596 (NTIS/PS—79/1059)
NITROGEN OXIDES/BIBLIOGRAPHIES
Nitrogen oxide air pollution. part 4. Biological effects (a bibliograhy with abstracts). Report for 1964-August 1979, 5:24777 (NTIS/PS—79/1060)
NITROGEN OXIDES/EMISSION
Nitrogen oxide air pollution. Part 5. Emissions studies. Volume 2. 1975-1977 (a bibliography with abstracts). Report for 1975-77, 5:24597 (NTIS/PS—79/1061)
Nitrogen oxide air pollution. Part 5. Emissions studies. Volume 3. 1978-August, 1979 (a bibliography with abstracts). Report for 1975-August 1979, 5:24598 (NTIS/PS—79/1062)
NITROGEN OXIDES/RADIOSENSITIVITY EFFECTS
Does oxygen enhance the radiation: induced inactivation of penicillinase. Progress report, December 1, 1979-November 30, 1980, 5:24734 (DOE/EV/03221—62)
NITROMETHANE/DETONATIONS
Effect of a chemical inhomogeneity on steady-state detonation velocity, 5:24585
NITROMETHANE/ISOMERS
Effect of a chemical inhomogeneity on steady-state detonation velocity, 5:24585
NITROSO COMPOUNDS/MUTAGENESIS
Specific-locus test shows ethylnitrosourea to be the most potent mutagen in the mouse, 5:24774
NOISE POLLUTION/POLLUTION ABATEMENT
Control of vibration and blast noise from surface coal mining. Volume I. Open file report (final) 1 July 1975-28 February 1978, 5:23519 (PB—299887)
Control of vibration and blast noise from surface coal mining. Volume II. Open file report (final) 1 July 1975-28 February 1978, 5:23520 (PB—299888)
Control of vibration and blast noise from surface coal mining. Volume III. Open file report (final) 1 July 1975-28 February 1978, 5:23521 (PB—299889)
NOISE POLLUTION/POLLUTION CONTROL
Control of vibration and blast noise from surface coal mining. Volume IV. Executive report. Open file report (final) 1 July 1975-28 February 1978, 5:23522 (PB—299890)
NONAXIAL NUCLEI
See DEFORMED NUCLEI
NONDESTRUCTIVE TESTING/IMAGE PROCESSING
Overview of image reconstruction, 5:25105 (BNL—27665)
NONLINEAR PROBLEMS/PLASMA SIMULATION
Simulation of drift-cone modes, 5:25029
NONLINEAR SYSTEMS
See NONLINEAR PROBLEMS
NONMETALS
See also PHOSPHORUS
SULFUR
NONMETALS/PLASTICITY
Use of endochronic plasticity for multi-dimensional small and large strain problems, 5:24385 (ANL-CT—79-19)
NORTH CAROLINA/MAGNETIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
NORTH CAROLINA/RADIOMETRIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
NORTH DAKOTA/COAL DEPOSITS
Lignite drilling during 1978 in western North Dakota: Adams, Billings, Bowman, Burke, Golden Valley, Hettinger, McKenzie, McLean, and Slope Counties, 5:23535
NORTH DAKOTA/COAL MINES
Evaluation of the environmental effects of western surface coal mining. Volume II. Mine inventory. Final report, 5:23529 (PB—301249)
NORTH DAKOTA/ENERGY SOURCE DEVELOPMENT
Proceedings of the third workshop on the energy development board of Mercer County, North Dakota, 5:24177 (CONF-791178—)
NORTH DAKOTA/GEOCHEMICAL SURVEYS
Hydrogeochemical and stream sediment reconnaissance basic data for Dickinson NTMS Quadrangle, North Dakota, 5:23689 (GJBX—99(80))
NORTHERN IRELAND
See UNITED KINGDOM
NOZZLES
See also JET DRILLS
NOZZLES/STRESS ANALYSIS
Determination of K-factors for arbitrarily shaped flaws at pressure vessel nozzle corners, 5:24045 (CONF-791118—11)
NPR REACTOR
See N-REACTOR
N-REACTOR/FUEL RODS
Device and method for shortening reactor process tubes (Patent), 5:24066
NSLS
Use of a synchrotron radiation x-ray microprobe for elemental analysis at the National Synchrotron Light Source, 5:24487 (BNL—27611)
NUCLEAR DATA COLLECTIONS
ENSDF: its structure, contents, and use in applied research, 5:24886 (CONF-791243—1)

NUCLEAR ELECTRIC MOMENTS
What can we learn about nuclear electric dipole moments from parity nonconservation in atomic transitions?, 5:24864
NUCLEAR ENERGY/HEALTH HAZARDS
Tentative outline of work scope and organization for a study of the risks from energy production in the US, 5:24080 (ALO—81)
NUCLEAR ENERGY/RISK ASSESSMENT
Tentative outline of work scope and organization for a study of the risks from energy production in the US, 5:24080 (ALO—81)
NUCLEAR EXPLOSIONS/RECORDING SYSTEMS
Microprocessor-controlled time domain reflectometer for dynamic shock position measurements, 5:24586
NUCLEAR EXPLOSIONS/YIELDS
Microprocessor-controlled time domain reflectometer for dynamic shock position measurements, 5:24586
NUCLEAR FACILITIES
See also FEED MATERIALS PLANTS
FUEL REPROCESSING PLANTS
NUCLEAR FACILITIES/WASTE HEAT UTILIZATION
Thermally driven open-cycle heat pump system, 5:24306 (CONF-800549—1)
NUCLEAR INDUSTRY/ECONOMIC IMPACT
Final environmental impact statement: US Spent Fuel Policy. Charge for spent fuel storage, 5:23726 (DOE/EIS—0015(Vol.4))
NUCLEAR MATTER/BARYON RESONANCES
Thermodynamic behavior of non-strange baryonic matter, 5:24941
NUCLEAR MATTER/EQUATIONS OF STATE
Thermodynamic behavior of non-strange baryonic matter, 5:24941
NUCLEAR MODELS
See also CRANKING MODEL
NUCLEAR MODELS/DISSIPATION FACTOR
One-body dissipation and nuclear dynamics, 5:24948
NUCLEAR POWER/ENVIRONMENTAL IMPACTS
Environmental problems of the uranium mining and milling industry, 5:23755
NUCLEAR POWER/RADIOACTIVE EFFLUENTS
Iodine-129 dose to the world population from the nuclear power industry, 5:24628 (CONF-791103—107)
NUCLEAR POWER PLANTS/ELECTRIC CABLES
Minimizing fire potential in power plant cable systems, 5:24074 (EPRI-EL—1263)
NUCLEAR POWER PLANTS/FORECASTING
Neutron and fuel cycle kinetics analogy, 5:24187 (CONF-791103—110)
NUCLEAR POWER PLANTS/FUEL ELEMENTS
ACFAC: a cash flow analysis code for estimating product price from an industrial operation, 5:24069 (ORNL/TM—7150)
NUCLEAR POWER PLANTS/HEALTH HAZARDS
Health and safety. Preliminary comparative assessment of the satellite power system (SPS) and other energy alternatives, 5:23847 (DOE/ER—0053)
NUCLEAR POWER PLANTS/SOCIO-ECONOMIC FACTORS
Socio-economic impacts of nuclear power plants (Including mitigation plans), 5:24188
NUCLEAR REACTORS
See REACTORS
NUCLEAR STRUCTURE/NUCLEAR DATA COLLECTIONS
ENSDF: its structure, contents, and use in applied research, 5:24886 (CONF-791243—1)
NUCLEAR WASTES
See RADIOACTIVE WASTES
NUCLEAR WEAPON TESTS
See NUCLEAR EXPLOSIONS
NUCLEON-NUCLEON INTERACTIONS
See also PROTON-PROTON INTERACTIONS
NUCLEON-NUCLEON INTERACTIONS/MATHEMATICAL MODELS
Phenomenological relativistic quantum mechanics of the NNπ system, 5:24945
NUCLEON-NUCLEON INTERACTIONS/SCATTERING AMPLITUDES
New optimal polynomial theory for NN-scattering, 5:24844 (DOE/ER/10516—T2)
NUCLEOTIDES
See also AMP
ATP
NUCLEOTIDES/ABSORPTION SPECTRA
Interactions of 4-nitroquinoline 1-oxide with deoxyribodinucleotides, 5:24679
NUCLEOTIDES/NMR SPECTRA
Interactions of 4-nitroquinoline 1-oxide with deoxyribodinucleotides, 5:24679
NUTS (SEEDS)
See SEEDS

O

OAK RIDGE NATIONAL LABORATORY
See ORNL
OBESITY
See METABOLIC DISEASES
OCEAN THERMAL ENERGY CONVERSION/ENVIRONMENTAL IMPACTS
Consequences of natural upwelling in oligotrophic marine ecosystems, 5:23862 (BNL—27710)
OCEAN THERMAL POWER PLANTS
Performance improvement for ocean thermal energy conversion systems. Final report (Helical rotor inserts for preventing biofouling), 5:23869 (DSE—0034-T1)
OCEAN THERMAL POWER PLANTS/BIOLOGICAL FOULING
Biofouling, corrosion, and materials overview, 5:23864 (CONF-790631—(Vol.2))
OCEAN THERMAL POWER PLANTS/COMPUTERIZED SIMULATION
Dynamic and off-design analysis of OTEC closed cycle power systems, 5:23863 (CONF-790631—(Vol.1))
OCEAN THERMAL POWER PLANTS/CORROSION
Biofouling, corrosion, and materials overview, 5:23864 (CONF-790631—(Vol.2))
OCEAN THERMAL POWER PLANTS/DESIGN
Dynamic and off-design analysis of OTEC closed cycle power systems, 5:23863 (CONF-790631—(Vol.1))
Energy conversion system for deriving useful power from sources of low level heat (Patent), 5:23870
OCEAN THERMAL POWER PLANTS/FEASIBILITY STUDIES
Description of the system planning process at Florida Power Corporation. Task I. Report No. FC-5237-1, 5:23867 (DOE/ET/29187—T3)
Evaluation of APL OTEC 10/20 MWE Pilot Plantship. Final report, 5:23866 (DOE/ET/21002—1)
OCEAN THERMAL POWER PLANTS/MATERIALS
Biofouling, corrosion, and materials overview, 5:23864 (CONF-790631—(Vol.2))
OCEAN THERMAL POWER PLANTS/MOORINGS
Preliminary designs for OTEC Stationkeeping Subsystems (SKSS). Summary report, 5:23868 (DOE/NOAA/OTEC—29(Summ.))
OCEAN THERMAL POWER PLANTS/PILOT PLANTS
Evaluation of APL OTEC 10/20 MWE Pilot Plantship. Final report, 5:23866 (DOE/ET/21002—1)
OCEAN THERMAL POWER PLANTS/SPECIFICATIONS
Energy conversion system for deriving useful power from sources of low level heat (Patent), 5:23870
OCEAN THERMAL POWER PLANTS/SYSTEMS ANALYSIS
Evaluation of APL OTEC 10/20 MWE Pilot Plantship. Final report, 5:23866 (DOE/ET/21002—1)
ODOCOILEUS
See DEER
OFFICE BUILDINGS/ENERGY CONSERVATION
Federal energy conservation programs pursuant to section 381 of the Energy Policy and Conservation Act (Public Law 94-163). Annual report to Congress, 5:24190 (DOE/CS—0162)
OFF-PEAK ENERGY STORAGE/ELECTRIC BATTERIES
BEST Facility: accelerating the development of utility load-leveling batteries, 5:24163
OFF-PEAK ENERGY STORAGE/LITHIUM-SULFUR BATTERIES
Conceptual design of electrical balance of plant for advanced battery energy storage facility. Annual report, March 1979 (20-MW, 100 MWh), 5:24155 (ANL—80-16)
Design and testing of a large-scale lithium-silicon/FeS load-leveling cell, 5:24104
Development of advanced batteries at Argonne National Laboratory. Summary report for 1979, 5:24103 (ANL—80-32)
OFF-PEAK ENERGY STORAGE/SODIUM-SULFUR BATTERIES
Current status of the hollow fiber sodium-sulfur cell (0.5- and 5-Ah), 5:24124
Sodium-sulfur battery: a progress report (1 MW), 5:24160
OFFSHORE OPERATIONS
See also UNDERWATER OPERATIONS
OFFSHORE OPERATIONS/WASTE MANAGEMENT
Method for removing suspended oil droplets from water (Patent), 5:23587
OFFSHORE PLATFORMS/DESIGN
Oil-production platform and method of assembling and installing the same on a sea bed (Patent), 5:23581
Subfloor for offshore production platform (Patent), 5:23585
OFFSHORE PLATFORMS/INSTALLATION
Oil-production platform and method of assembling and installing the same on a sea bed (Patent), 5:23581

OFFSHORE PLATFORMS/MOORINGS
Preliminary designs for OTEC Stationkeeping Subsystems (SKSS). Summary report, 5:23868 (DOE/NOAA/OTEC—29(Summ.))
OHIO/MAGNETIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
OHIO/RADIOMETRIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
OIL BURNERS/PERFORMANCE TESTING
R and D activities in pulse combustion at BNL, 5:24248 (BNL—27602)
OIL FIELDS/BOREHOLES
Bell Canyon Test (BCT) instrumentation development, 5:24571 (SAND—80-0408C)
OIL POLLUTION CONTAINMENT/DESIGN
Floating-type anti-oil anti-impact and anti-wave barrier (Patent), 5:23608
Floating-type anti-oil anti-impact anti-wave barrier (Patent), 5:23609
OIL RESIDUES
See PETROLEUM RESIDUES
OIL SAND DEPOSITS/DIRECTIONAL DRILLING
Directional drilling in tar sands, 5:23620 (SAND—80-1134)
OIL SANDS/HOT-WATER PROCESSES
Process of treating bituminous sands conveyor belt with release agent (Patent), 5:23641
OIL SANDS/PROCESSING
Recovery of bitumen from tar sands (Patent), 5:23640
OIL SATURATION/MEASURING METHODS
Single-well chemical tracer test simulator handbook: improved accuracy and interpretation for residual oil saturation measurement, 5:23573 (DOE/BC/20006—14)
OIL SHALE DEPOSITS
See also ROCK SPRINGS SITES
OIL SHALE DEPOSITS/LEASING
Economic issues in oil shale leasing policy, 5:23657
OIL SHALE DEPOSITS/SHAFT EXCAVATIONS
Experiences in equipping a 96-inch-diameter shaft, and mining bulk samples of oil shale, dawsonite and nahcolite, 5:23621
OIL SHALE DEPOSITS/WELL DRILLING
Drilling and casing a large-diameter shaft in he Piceance Creek Basin, 5:23623
OIL SHALE INDUSTRY/HEALTH HAZARDS
Health studies of oil shale workers, 5:23654
OIL SHALE INDUSTRY/OCCUPATIONAL DISEASES
Health studies of oil shale workers, 5:23654
OIL SHALE INDUSTRY/POLLUTION
Trace element release and transport associated with shale oil production, 5:23665
OIL SHALE INDUSTRY/POLLUTION REGULATIONS
EPA regulatory/research program, 5:23669
OIL SHALE INDUSTRY/REGULATIONS
EPA Oil Shale Research/Regulatory Program, 5:23670
OIL SHALE INDUSTRY/TOXIC MATERIALS
Toxic trace elements and oil shale production, 5:23656
OIL SHALE INDUSTRY/WASTE DISPOSAL
Review of the environmental impact of ground disposal of oil shale wastes, 5:24645
OIL SHALE INDUSTRY/WATER SUPPLY
Water management for oil shale mining and retorting in the Piceance Creek Basin, Colorado, 5:23658
OIL SHALE MINING
See also SURFACE MINING
UNDERGROUND MINING
Experiences in equipping a 96-inch-diameter shaft, and mining bulk samples of oil shale, dawsonite and nahcolite, 5:23621
OIL SHALE MINING/ENVIRONMENTAL EFFECTS
Groundwater quality monitoring of western oil shale development: identification and priority ranking of potential pollution sources, 5:23661 (PB—300536)
OIL SHALE MINING/ENVIRONMENTAL IMPACTS
Environmental analysis for the Bureau of Mines oil shale research facility, 5:23662
OIL SHALE MINING/HAZARDS
Methane encountered at the Bureau of Mines oil shale shaft, 5:23653
Potential for fires and explosions in oil shale mining and processing, 5:23652
OIL SHALE PROCESSING PLANTS/WATER SUPPLY
Water management for oil shale mining and retorting in the Piceance Creek Basin, Colorado, 5:23658
OIL SHALES
See also BLACK SHALES
OXY MODIFIED IN-SITU PROCESS
OIL SHALES/BIOLOGICAL EFFECTS
Potential toxic effects on aquatic biota from oil shale development, 5:23666
OIL SHALES/ELASTICITY
Ultrasonic velocity and elastic constants of Antrim oil shale, 5:23643 (FE—2346-37)
OIL SHALES/ENERGY SOURCE DEVELOPMENT
Energy from the west: energy resource development systems report. Volume III: oil shale. Final report, 1975-1978, 5:23668 (PB—299179)
OIL SHALES/EXPLOSIVE FRACTURING
Explosively produced fracture of oil shale. Annual report, April 1978-March 1979, 5:23619 (LA—8104-PR)
OIL SHALES/FISCHER ASSAY
Chemical and physical properties of oil shale dust and correlations with laboratory fire and explosivity test results, 5:23650
OIL SHALES/HYDRAULIC TRANSPORT
Pipeline transportation of oil shale, 5:23644
OIL SHALES/IGNITION
Chemical and physical properties of oil shale dust and correlations with laboratory fire and explosivity test results, 5:23650
Laboratory and fire explosivity testing of oil shale dust, 5:23651
OIL SHALES/INFORMATION SYSTEMS
Bureau of Mines oil shale data bank, 5:23617
OIL SHALES/IN-SITU COMBUSTION
Evaluation of retort performance from gas data, 5:23633
High temperature reactions of oil shale minerals and their benefit to oil shale processing in place, 5:23635
In situ combustion of Antrim oil shale: field test of Tejas petroleum engineers burner, 5:23626 (FE—2346-48)
OIL SHALES/IN-SITU PROCESSING
Comparison of dielectric heating and pyrolysis of eastern and western oil shales (IITRI RF Process; leaching of U), 5:23632
OIL SHALES/IN-SITU RETORTING
Environmental research for in situ oil shale processing, 5:23667
Investigation of the Geokinetics horizontal in situ oil shale retorting process. Quarterly report, January-March 1980, 5:23625 (DOE/LETC/10787—44)
Microbial interactions with aqueous effluents derived from in situ fossil fuel processing, 5:23663
Phytotoxicity and plant response to aqueous effluents derived from an in situ oil shale process water (Effects of Omega-9 water on seed germination and growth), 5:23664
Progress report on the geokinetics horizontal in situ retorting process, 5:23631
Spent shale compaction for void volume generation in in situ oil shale processing, 5:23638
Toxicological evaluation of an in situ oil shale process water, 5:23648
OIL SHALES/MEETINGS
Eleventh oil shale symposium proceedings, 5:23616
Twelfth oil shale symposium proceedings, 5:23615
OIL SHALES/MODIFIED IN-SITU PROCESSES
Progress in Occidental's shale oil activities, 5:23637
OIL SHALES/MUTAGEN SCREENING
Mutagenicity testing of aqueous materials from alternate fuel production, 5:24765 (CONF-790663—3)
OIL SHALES/PHYSICAL PROPERTIES
Effects of mositure and organic content on the thermophysical properties of Green River oil shale, 5:23646
OIL SHALES/RETORTING
Oil Shale Project Run summary. Small Retort Run S-16, 5:23639 (UCID—18618)
Product yields, 5:23624
OIL SHALES/SPONTANEOUS COMBUSTION
Chemical and physical properties of oil shale dust and correlations with laboratory fire and explosivity test results, 5:23650
OIL WELLS
See also PETROLEUM
OIL WELLS/CARBON DIOXIDE INJECTION
Carbon dioxide for the recovery of crude oil: a literature search to June 30, 1979. Final reportp, 5:23577 (DOE/BETC/5785—1)
Enhanced oil recovery by CO_2 foam flooding. First annual report, 5:23579 (DOE/MC/03259—6)
OIL WELLS/FLUID INJECTION
Lignosulfonates carboxylated with cloroacetic acid as additives in oil recovery processes involving chemical recovery agents (Patent), 5:23588
OIL WELLS/LINERS
Polymer concrete composites for the production of high strength pipe and linings in high temperature corrosive environments (Patent), 5:24444
OIL WELLS/MICROEMULSION FLOODING
Mechanism of oil bank formation, coalescence in porous media and emulsion stability. Annual report, June 1978-May 1979, 5:23575 (DOE/BC/10069—6)

Precipitation of petroleum sulfonates by magnesium ions, 5:23578 (DOE/BETC/RI—80/3)
OIL WELLS/PUMPS
Shock absorber for oil well pumping unit (Patent), 5:23584
OIL WELLS/RADIOACTIVE TRACER LOGGING
Method for monioring fluid movement behind casing in oil and gas wells (Patent), 5:23586
OIL WELLS/UNDERWATER OPERATIONS
Method and apparatus for recovery of subsea well equipment (Patent), 5:23582
OIL WELLS/WATERFLOODING
Oil recovery by waterflooding with thickened surfactant solutions (Patent), 5:23583
OILS
See also FUEL OILS
SHALE OIL
OILS/VISCOSITY
Effect of principal stress magnitudes on hydrofracturing orientation, 5:24791 (UCRL—15234)
OKLAHOMA/AEROSOL MONITORING
Study of the nature of ozone, oxides of nitrogen, and nonmethane hydrocarbons in Tulsa, Oklahoma. Volume I. project description and data summaries, 5:24614 (PB—300481)
OKLAHOMA/SEISMICITY
Seismicity of the salt areas of Texas, Louisiana, Oklahoma and Kansas, 5:24785 (UCRL—15221)
OLIGONUCLEOTIDES
See NUCLEOTIDES
ONCOGENIC TRANSFORMATIONS/RADIOINDUCTION
Oncogenic transformation of mammalian cells in vitro with split doses of x rays, 5:24740
ONIONS/SOLAR DRYING
Application of solar energy to continuous belt dehydration, 5:23924 (SERI/TP—333-429)
Review of four DOE-sponsored solar dehydration systems, 5:23906 (SERI/TP—333-429)
OPEN PLASMA DEVICES/MAGNETIC FIELD REVERSAL
Production of field-reversed configurations with a magnetized coaxial plasma gun, 5:25049 (LA-UR—80-1104)
OPEN-FLOW COLLECTORS
See TRICKLE-TYPE COLLECTORS
OPTICAL SCANNERS/PATTERN RECOGNITION
Detection of perpendicular line intersections, 5:24541
OPTICALLY THICK PLASMA/DENSITY
Extension of liquid-metal theory to dense partially ionized plasmas, 5:24834
OPTICALLY THICK PLASMA/THERMODYNAMIC PROPERTIES
Extension of liquid-metal theory to dense partially ionized plasmas, 5:24834
OPTICS/IMAGE PROCESSING
Overview of image reconstruction, 5:25105 (BNL—27665)
OPTICS/STANDARDIZED TERMINOLOGY
Conventions and formulas for using the Mueller-Stokes calculus in ellipsometry, 5:24971 (LBL—10172)
ORBITAL SOLAR POWER PLANTS
Selection of alternative central-station technologies for the Satellite Power System (SPS) comparative assessment, 5:23846 (DOE-ER—0052)
ORBITAL SOLAR POWER PLANTS/ENVIRONMENTAL IMPACTS
Climate and energy: a comparative assessment of the Satellite Power System (SPS) and alternative energy technologies, 5:23798 (DOE/ER—0050)
Comparative assessment of environmental welfare issues associated with the satellite power system (SPS) and alternative technologies, 5:23849 (DOE/ER—0055)
ORBITAL SOLAR POWER PLANTS/HEALTH HAZARDS
Health and safety. Preliminary comparative assessment of the satellite power system (SPS) and other energy alternatives, 5:23847 (DOE/ER—0053)
ORBITAL SOLAR POWER PLANTS/LAND REQUIREMENTS
Preliminary comparative assessment of land use for the satellite power system (SPS) and alternative electric energy technologies, 5:23848 (DOE/ER—0054)
ORBITAL SOLAR POWER PLANTS/NET ENERGY
Comparative analysis of net energy balance for satellite power systems (SPS) and other energy systems, 5:23850 (DOE/ER—0056)
ORBITAL SOLAR POWER PLANTS/PUBLIC OPINION
Some questions and answers about the Satellite Power System (SPS), 5:23865 (DOE/ER—0049/1)
ORE PROCESSING/SOLAR PROCESS HEAT
Solar production of industrial process steam (NL Industries, Inc. Project; Newberry Springs, California), 5:23931 (SERI/TP—333-429)
OREGON/ENVIRONMENTAL IMPACTS
Geothermal environmental impact assessment: subsurface environmental assessment for four geothermal systems, 5:23994 (PB—300851)
OREGON/GEOTHERMAL EXPLORATION
Mount Hood, Oregon, 5:23985
OREGON/GEOTHERMAL RESOURCES
Mount Hood, Oregon, 5:23985
OREGON/MAGNETIC SURVEYS
Aerial radiometric and magnetic survey: Adel National Topographic Map, Oregon. Rocky Mountain, 1979, 5:23692 (GJBX—104(80))
Aerial radiometric and magnetic survey: Jordan Valley National Topographic Map, Idaho and Oregon. Rocky Mountain, 1979, 5:23685 (GJBX—95(80))
OREGON/RADIOMETRIC SURVEYS
Aerial radiometric and magnetic survey: Adel National Topographic Map, Oregon. Rocky Mountain, 1979, 5:23692 (GJBX—104(80))
Aerial radiometric and magnetic survey: Jordan Valley National Topographic Map, Idaho and Oregon. Rocky Mountain, 1979, 5:23685 (GJBX—95(80))
OREGON/RESOURCE DEVELOPMENT
Geothermal environmental impact assessment: subsurface environmental assessment for four geothermal systems, 5:23994 (PB—300851)
ORGANIC CHLORINE COMPOUNDS
See also DDT
PVC
ORGANIC CHLORINE COMPOUNDS/GLOBAL ASPECTS
Report on the progress of regulations to protect stratospheric ozone. Annual report 1978-79, 5:24622 (PB—301368)
ORGANIC CHLORINE COMPOUNDS/POLLUTION REGULATIONS
Report on the progress of regulations to protect stratospheric ozone. Annual report 1978-79, 5:24622 (PB—301368)
ORGANIC CHLORINE COMPOUNDS/WASTE DISPOSAL
Delicate disposal of PCBs, 5:24030
ORGANIC CHLORINE COMPOUNDS/WATER POLLUTION CONTROL
Oxidation techniques in Drinking water treatment. drinking water pilot project. Report IIa. Advanced treatment technology. Final report, 5:24666 (PB—301313)
ORGANIC COMPOUNDS
See also CHEMICAL FEEDSTOCKS
HYDROCARBONS
HYDROXY COMPOUNDS
NUCLEOTIDES
ORGANIC OXYGEN COMPOUNDS
ORGANIC POLYMERS
PROTEINS
ORGANIC COMPOUNDS/ATMOSPHERIC CHEMISTRY
Atmospheric reaction products of organic compounds. Final report, 5:24623 (PB—301384)
ORGANIC COMPOUNDS/MUTAGEN SCREENING
Screening for mutagenic response of six coded chemicals in the CHO/HGPRT system, 5:24763 (CONF-7910146—1)
ORGANIC FLUORINE COMPOUNDS
See also FLUORINATED ALIPHATIC HYDROCARBONS
ORGANIC FLUORINE COMPOUNDS/MUTAGENESIS
Unstable, non-mutational expression of resistance to the thymidine analogue, trifluorothymidine in CHO cells, 5:24764
ORGANIC OXYGEN COMPOUNDS
See also EPOXIDES
HYDROXY COMPOUNDS
ORGANIC OXYGEN COMPOUNDS/CHEMICAL PREPARATION
Heat and chemically resistant membranes, 5:24166
ORGANIC POLYMERS
See also PLASTIC FOAMS
POLYESTERS
POLYVINYLS
RUBBERS
ORGANIC POLYMERS/CHEMICAL PREPARATION
Heat and chemically resistant membranes, 5:24166
ORGANIC SOLAR CELLS/DESIGN
Photovoltaic cell (Patent), 5:23827
Photovoltaic cell comprising metal-free phthalocyanine (Patent), 5:23828
ORGANIC SOLAR CELLS/EFFICIENCY
Photovoltaic cell comprising metal-free phthalocyanine (Patent), 5:23828
ORGANIC SOLVENTS/CHEMICAL COMPOSITION
Separation and structure elucidation of coal molecule fragments. Final report, February 1, 1976-August 31, 1979, 5:23453 (DOE/EV/2856—5)

ORGANIC SOLVENTS/FRACTIONATION
Separation and structure elucidation of coal molecule fragments. Final report, February 1, 1976-August 31, 1979, 5:23453 (DOE/EV/2856—5)
ORGANS
See also KIDNEYS
SKELETON
ORGANS/RADIONUCLIDE KINETICS
Curium-243,4 in the tissues of the adult baboon (Time-dependent effects of DTPA administration on excretion), 5:24757 (COO—3382-18)
ORNL
(Oak Ridge National Laboratory.)
ORNL/DATA BASE MANAGEMENT
Spatial data on energy, environmental, health, and socio-economic themes at Oak Ridge National Laboratory: 1979 inventory, 5:24175 (ORNL—5636)
OSTEOSARCOMAS/RADIOINDUCTION
Osteosarcomas among beagles exposed to ^{239}Plutonium. Technical report No. 34, 5:24751 (DOE/EV/02874—68)
OUTER CONTINENTAL SHELF
See CONTINENTAL SHELF
OVARIES/AUTORADIOGRAPHY
Microdistribution of ^{243} ^{4}Cm in the ovary of an adult baboon, 5:24758 (COO—3382-18)
OVARIES/RADIONUCLIDE KINETICS
Microdistribution of ^{243} ^{4}Cm in the ovary of an adult baboon, 5:24758 (COO—3382-18)
OXIDATION/CHEMICAL REACTION KINETICS
Study of coal oxidation by charged particle activation analysis, 5:23452 (BNL—27607)
OXIDATION/PHOTOCHEMICAL REACTIONS
Photooxidation of antenna bacteriochlorophyll in chromatophores from carotenoidless mutant Rhodopseudomonas sphaeroides and the attendant loss of dimeric exciton interaction, 5:24682
OXIDES/CORROSION RESISTANCE
Improved structural silicon nitride materials containing rare earth oxides (Patent), 5:24433
OXIDES/FABRICATION
Improved structural silicon nitride materials containing rare earth oxides (Patent), 5:24433
OXIDES/PHASE DIAGRAMS
Improved structural silicon nitride materials containing rare earth oxides (Patent), 5:24433
OXIRANS
See EPOXIDES
OXY MODIFIED IN-SITU PROCESS/PLANNING
Progress in Occidental's shale oil activities, 5:23637
OXYGEN/ATOM-MOLECULE COLLISIONS
Collisional ionization of Cs and K by O_2, 5:24823
OXYGEN/CHEMISTRY
Sulfur and oxygen chemistry at free surfaces and grain boundaries of iron alloys, 5:24407
OXYGEN/MEMBRANE TRANSPORT
Oxygen effect and adaptive reactions of cells. Report 2. Kinetics of respiration of tumor cells differing in initial respiration level (γ rays; Ehrlich ascites tumor cells), 5:24747
OXYGEN/PRODUCTION
Large oxygen plant economics and reliability, 5:23786
OXYGEN/RADIOSENSITIVITY EFFECTS
Does oxygen enhance the radiation: induced inactivation of penicillinase. Progress report, December 1, 1979-November 30, 1980, 5:24734 (DOE/EV/03221—62)
Oxygen effect and adaptive reactions of cells. Report 2. Kinetics of respiration of tumor cells differing in initial respiration level (γ rays; Ehrlich ascites tumor cells), 5:24747
OXYGEN/RAMAN SPECTRA
Effect of satellite Q-branches on temperatures computed from oxygen vibrational Raman intensities, 5:24817
OXYGEN/REMOVAL
Glow discharge conditioning of the PDX vacuum vessel, 5:25097
OXYGEN/SEGREGATION
Sulfur and oxygen chemistry at free surfaces and grain boundaries of iron alloys, 5:24407
OXYGEN/SEPARATION PROCESSES
Effect of the degree of hydration of the adsorbent on the chromatographic analysis of common gases, 5:24493 (DP-TR—9)
OXYGEN 16 REACTIONS/ALPHA-TRANSFER REACTIONS
^{24}Mg(^{16}O,^{12}C)^{28}Si and ^{24}Mg(^{16}O,^{16}O)^{24}Mg reactions at backward angles, 5:24904
Resonant behavior of the ^{24}Mg(^{16}O,^{12}C)^{28}Si reaction, 5:24905
OXYGEN 16 REACTIONS/COMPOUND-NUCLEUS REACTIONS
Decay of deformed and superdeformed nuclei formed in heavy ion reactions, 5:24910
Resonant behavior of the ^{24}Mg(^{16}O,^{12}C)^{28}Si reaction, 5:24905
OXYGEN 16 REACTIONS/ELASTIC SCATTERING
^{24}Mg(^{16}O,^{12}C)^{28}Si and ^{24}Mg(^{16}O,^{16}O)^{24}Mg reactions at backward angles, 5:24904
90^{9} excitation functions for elastic scattering of ^{28}Si+ ^{16}O and ^{28}Si+ ^{12}C, 5:24908
OXYGEN 16 REACTIONS/FUSION REACTIONS
Coherence angle in heavy-ion reactions, 5:24895
Complete fusion of ^{15}N+ ^{27}Al, 5:24906
Fusion of ^{16}O+/sup 148,150,152,154/Sm at sub-barrier energies, 5:24916
OXYGEN 16 REACTIONS/INELASTIC SCATTERING
^{24}Mg(^{16}O,^{12}C)^{28}Si and ^{24}Mg(^{16}O,^{16}O)^{24}Mg reactions at backward angles, 5:24904
OXYGEN 16 REACTIONS/RESONANCE SCATTERING
Resonant behavior of the ^{24}Mg(^{16}O,^{12}C)^{28}Si reaction, 5:24905
OXYGEN 16 TARGET/ALPHA REACTIONS
Description of direct nuclear rearrangement reactions using various coupled channel equations, 5:24946
OXYGEN 16 TARGET/ALUMINIUM 27 REACTIONS
Backward angle cross sections for ^{27}Al+ ^{16}O reaction products, 5:24898
OXYGEN 16 TARGET/DEUTERON REACTIONS
Description of direct nuclear rearrangement reactions using various coupled channel equations, 5:24946
OXYGEN 16 TARGET/PION REACTIONS
Pion absorption processes (32 to 74 MeV), 5:24896 (COO—3244-72)
OXYGEN 18 REACTIONS/COMPOUND-NUCLEUS REACTIONS
High-spin properties of ^{164}Er in the multiple band crossing region, 5:24922
OXYGEN 18 REACTIONS/FUSION REACTIONS
Complete fusion of ^{15}N+ ^{27}Al, 5:24906
OXYGEN 18 TARGET/PION MINUS REACTIONS
Core polarization effects in inelastic pion-nucleus scattering (Glauber theory), 5:24947
OXYGEN 18 TARGET/PION PLUS REACTIONS
Core polarization effects in inelastic pion-nucleus scattering (Glauber theory), 5:24947
OXYGEN 18 TARGET/PION REACTIONS
Pion absorption processes (32 to 74 MeV), 5:24896 (COO—3244-72)
OXYGEN EFFECT (RADIOBIOLOGY)
See OXYGEN
RESPONSE MODIFYING FACTORS
OXYGEN ENRICHMENT/EQUIPMENT
Optimization of air separation plants for combined cycle MHD-power plant applications, 5:24222 (DOE/NASA/2674—80/10)
OXYGEN IONS/DIFFUSION
AES and XPS study of plutonium oxidation, 5:24415
OXYGEN IONS/ION-ATOM COLLISIONS
Charge exchange measurements in helium using a double tandem accelerator-decelerator source of low energy highly stripped oxygen ions, 5:24826
Differential charge transfer to the continuum by ions in atomic hydrogen. Progress report and renewal proposal, 5:24819 (DOE/ER/10512—T1)
Electron-capture collisions at keV energies of boron and other multiply charged ions with atoms and molecules. II. Atomic hydrogen, 5:24824
OXYMETHYLENE
See FORMALDEHYDE
OYSTERS/INFECTIOUS DISEASES
Modified procedure for the recovery of naturally accumulated poliovirus from oysters, 5:24727
OZONE/ATMOSPHERIC CHEMISTRY
Report on the progress of regulations to protect stratospheric ozone. Annual report 1978-79, 5:24622 (PB—301368)
OZONE/POLLUTION REGULATIONS
Report on the progress of regulations to protect stratospheric ozone. Annual report 1978-79, 5:24622 (PB—301368)
OZONE/STRATOSPHERE
Report on the progress of regulations to protect stratospheric ozone. Annual report 1978-79, 5:24622 (PB—301368)

P

PACEMAKERS
See CARDIAC PACEMAKERS
PALLADIUM/CATALYTIC EFFECTS
Hydrotreating of pyrolysis gasoline (Patent), 5:23594
Removal of tritium and tritium-containing compounds from a gaseous stream (Patent), 5:23764

PALLADIUM 106 TARGET/TRITON REACTIONS
Search for nuclear structure dependence of analyzing powers for the (t,p) reaction in medium mass nuclei, 5:24917
PALLADIUM 108/ENERGY LEVELS
Search for nuclear structure dependence of analyzing powers for the (t,p) reaction in medium mass nuclei, 5:24917
PAPER INDUSTRY/AIR POLLUTION
Emissions and effluent control costs of the US pulp and paper industry, 5:24588 (ANL/EES-TM—83)
PAPER INDUSTRY/SOLAR PROCESS HEAT
Solar-industrial heat for New York State: a case study in regional impact on economic viability, 5:23911 (SERI/TP—333-429)
PAPER INDUSTRY/SOLID WASTES
Emissions and effluent control costs of the US pulp and paper industry, 5:24588 (ANL/EES-TM—83)
PAPER INDUSTRY/WATER POLLUTION
Emissions and effluent control costs of the US pulp and paper industry, 5:24588 (ANL/EES-TM—83)
PARABOLIC DISH COLLECTORS
Point-focus collector technology for IPH, 5:23938 (SERI/TP—333-429)
PARABOLIC DISH COLLECTORS/RESEARCH PROGRAMS
Point-Cocusing Thermal and Electric Applications Project. Annual technical report, fiscal year 1979. Volume I. Executive summary. JPL Publication 79-118, Volume I, 5:23859 (DOE/JPL—1060-31)
PARABOLIC POINT COLLECTORS
See PARABOLIC DISH COLLECTORS
PARABOLIC REFLECTORS
See also COMPOUND PARABOLIC CONCENTRATORS
PARABOLIC REFLECTORS/DESIGN
Solar concentrator (Patent), 5:23964
Solar power system, with high concentration, linear reflective solar panels (Patent), 5:23966
PARABOLIC TROUGH COLLECTORS/DESIGN
Concentrating solar heat collector (Patent), 5:23965
Solar concentrator (Patent), 5:23964
Solar power system, with high concentration, linear reflective solar panels (Patent), 5:23966
PARABOLIC TROUGH COLLECTORS/FABRICATION
Solar concentrator (Patent), 5:23964
PARAFFIN/FREEZING
Some observations on a paraffin-wax phase change experiment, 5:24100 (CONF-791108—24)
PARAFFIN/MELTING
Some observations on a paraffin-wax phase change experiment, 5:24100 (CONF-791108—24)
PARAFFIN/THERMAL CONDUCTIVITY
Some observations on a paraffin-wax phase change experiment, 5:24100 (CONF-791108—24)
PARAHO PROCESS/PERFORMANCE
Recent Paraho operations, 5:23642
PARATHORMONE/BIOLOGICAL EFFECTS
Comparison of the effects of prostaglandin E_2 and parathyroid hormone on plasma calcium concentration and osteoclast function, 5:24698
PARTHENOGENESIS
See REPRODUCTION
PARTICLE SIZE/CONTROL
Role of seed particles in the prediction and control of product particle size in fluidized-bed dryers, 5:23719 (ENICO—1036)
PARTICLE SIZE/MEASURING METHODS
Differential light scattering photometer for rapid analysis of single particles in flow, 5:24576
PARTICLE TRACKS/ELECTRON DOSIMETRY
Electron mean free paths in solid organic insulators, 5:24724
PARTICLES/CHEMICAL COMPOSITION
Detailed characterization of gaseous and size-resolved particulate pollutants at a south coast air basin smog receptor site: levels and modes of formation of sulfate, nitrate and organic particulates and their implications for control strategies. Final report November 1975-June 1978, 5:24620 (PB—301294)
Evaluation of stationary source particulate measurement methods. Volume V. Secondary lead smelters. Interim report oct 73-June 1977, 5:24608 (PB—300337)
Hydrocarbon characterization of agricultural waste burning. Final report, 5:24615 (PB—300916)
PARTON MODEL/QUANTUM CHROMODYNAMICS
Simple quantum-chromodynamic parametrizations of parton distributions beyond the leading order of asymptotic freedom, 5:24857
PASSIVE SOLAR COOLING SYSTEMS
Supplementary material on passive solar heating concepts. A compilation of published articles, 5:23891 (PNL-SA—7820)
PASSIVE SOLAR COOLING SYSTEMS/CONTROL SYSTEMS
Passive environmental temperature control system (Patent), 5:23874
PASSIVE SOLAR COOLING SYSTEMS/DESIGN
Passive solar home, 5:23902
PASSIVE SOLAR COOLING SYSTEMS/PERFORMANCE
Human comfort and auxiliary control considerations in passive solar structures, 5:23886 (LBL—10034)
PASSIVE SOLAR COOLING SYSTEMS/TEMPERATURE CONTROL
Passive environmental temperature control system (Patent), 5:23874
PASSIVE SOLAR HEATING SYSTEMS
Supplementary material on passive solar heating concepts. A compilation of published articles, 5:23891 (PNL-SA—7820)
PASSIVE SOLAR HEATING SYSTEMS/CONTROL SYSTEMS
Passive environmental temperature control system (Patent), 5:23874
PASSIVE SOLAR HEATING SYSTEMS/DESIGN
Passive solar single family residential project, 5:23900
Passive solar home, 5:23902
Residential passive solar energy design competition for North Carolina. Final report, November 1, 1978-April 9, 1979, 5:23889 (NCEI—0013)
PASSIVE SOLAR HEATING SYSTEMS/MEASURING INSTRUMENTS
Monitoring the performance of solar heated and cooled buildings. Volume 2. Measuring instruments - selection, calibration and installation. Final report, 5:23882 (EPRI-ER—1239(Vol.4))
PASSIVE SOLAR HEATING SYSTEMS/OPERATION
Passive solar single family residential project, 5:23900
PASSIVE SOLAR HEATING SYSTEMS/PERFORMANCE
Direct gainhome using concrete cored slab, 5:23903
Human comfort and auxiliary control considerations in passive solar structures, 5:23886 (LBL—10034)
Monitoring the performance of solar heated and cooled buildings. Volume 2. Measuring instruments - selection, calibration and installation. Final report, 5:23882 (EPRI-ER—1239(Vol.4))
PASSIVE SOLAR HEATING SYSTEMS/REVIEWS
Passive design tutorial, 5:23899
PASSIVE SOLAR HEATING SYSTEMS/TEMPERATURE CONTROL
Passive environmental temperature control system (Patent), 5:23874
PATIENTS/RADIOTHERAPY
High LET dose measurements in patients undergoing pion radiotherapy, 5:24725
PDX DEVICES/ION SOURCES
Development of the ion source for PDX neutral beam injection, 5:25063 (CONF-791102—161)
PDX DEVICES/SURFACE CLEANING
Glow discharge conditioning of the PDX vacuum vessel, 5:25097
PEARL SPAR
See DOLOMITE
PEAT/GASIFICATION
Advanced development of a short-residencemtime hydrogasifier. Quarterly technical progress report, October 1, 1979-December 31, 1979, 5:23427 (FE—3125-15)
Experimental program for the development of peat gasification. Task 2. Hydrogasification. Task 3. Fluidized-bed tests. Interim report No. 7, October 1, 1978-July 31, 1979, 5:23424 (FE—2469-48)
PEAT/HYDROGENATION
Experimental program for the development of peat gasification. Task 2. Hydrogasification. Task 3. Fluidized-bed tests. Interim report No. 7, October 1, 1978-July 31, 1979, 5:23424 (FE—2469-48)
PENETROMETERS/STANDARDS
Nuclear standards transmittal, 5:24566 (RDT-F—3-6T(ERRATA))
Nuclear standards transmittal, 5:24567 (RDT-F—3-6T-(4-80)(Amendt))
PENNING ION SOURCES/POWER SUPPLIES
1000-kVA arc power supply, 5:25052 (CONF-791102—166)
PENNSYLVANIA/MAGNETIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
PENNSYLVANIA/RADIOMETRIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
PEOPLES REPUBLIC OF CHINA
See CHINA
PERMANENT MAGNETS/PRODUCTION
Microstructure and magnetic properties of Fe-Cr-Co alloys, 5:24373

PERSONNEL
See also DIAL PAINTERS
PERSONNEL/RADIATION PROTECTION
National Waste Terminal Storage repository in a bedded salt formation for spent unreprocessed fuel. Occupational exposure and health physics studies. KE report No. 78-21-R, 5:23734 (ORO—5366-T2)
PERU/ENERGY POLICY
Framework for energy policy and technology assessment in developing countries: a case study of Peru, 5:24200 (BNL—27613)
PERU/TECHNOLOGY ASSESSMENT
Framework for energy policy and technology assessment in developing countries: a case study of Peru, 5:24200 (BNL—27613)
PETROCHEMICAL FEEDSTOCKS
See CHEMICAL FEEDSTOCKS
PETROLEUM
See also OIL WELLS
SHALE OIL
PETROLEUM/ALLOCATIONS
Analysis of Federal Government energy emergency programs. Energy policy study, Volume 5. AR/EI-80-05, 5:24195 (DOE/EIA—0201/5)
PETROLEUM/ENHANCED RECOVERY
Lignosulfonates carboxylated with cloroacetic acid as additives in oil recovery processes involving chemical recovery agents (Patent), 5:23588
PETROLEUM/FUEL CONSUMPTION
Historic and projected oil and gas consumption, 5:23605
PETROLEUM/PRICING REGULATIONS
Analysis of Federal Government energy emergency programs. Energy policy study, Volume 5. AR/EI-80-05, 5:24195 (DOE/EIA—0201/5)
PETROLEUM/SEPARATION PROCESSES
Method for removing suspended oil droplets from water (Patent), 5:23587
PETROLEUM COKE
See COKE
PETROLEUM PRODUCTS
PETROLEUM DEPOSITS
See also OIL FIELDS
PETROLEUM DEPOSITS/GEOLOGIC STRUCTURES
Michigan's Silurian oil and gas pools. Report of investigation 2, 5:23574
PETROLEUM DEPOSITS/LEASING
Alaska OCS Socioeconomic Studies Program. Technical rept. No. 38. Western Gulf of Alaska petroleum development scenarios: economic and demographic impacts, 5:23602 (PB—300697)
Alaska OCS socioeconomic studies program. Technical report No. 36. Northern Gulf of Alaska petroleum development scenarios: sociocultural impacts, 5:23603 (PB—300699)
Alaska OCS socioeconomic studies program. Technical report No. 43. Lower Cook Inlet and Shelikof Strait petroleum development scenarios. Final report, 5:23604 (PB—300701)
Modeling the number of bids received on federal offshore hydrocarbon leases by poisson-type models, 5:23601 (LA—8347-MS)
PETROLEUM DEPOSITS/OFFSHORE OPERATIONS
Outer continental shelf environmental monitoring concerns. Final report, 5:23607 (PB—299861)
PETROLEUM DEPOSITS/RESOURCE POTENTIAL
Limiting behavior of sampling proportional to random size, 5:23572 (CONF-791241—1)
PETROLEUM FRACTIONS
See also PETROLEUM RESIDUES
PETROLEUM FRACTIONS/PROCESSING
Slurry hydrogen treating processes (Patent), 5:23595
PETROLEUM INDUSTRY/COMPETITION
State of competition in gasoline marketing. The effects of refiner operation at retail (a study required by Title III of the Petroleum Marketing Practices Act), 5:23600 (DOE/PE—0019(Vol.1))
PETROLEUM INDUSTRY/ECONOMIC IMPACT
Alaska OCS socioeconomic studies program. Technical report No. 43. Lower Cook Inlet and Shelikof Strait petroleum development scenarios. Final report, 5:23604 (PB—300701)
PETROLEUM INDUSTRY/FINANCIAL INCENTIVES
Analysis of federal incentives used to stimulate energy production: an executive summary, 5:24182 (PNL—2410(Rev.2))
PETROLEUM INDUSTRY/SOCIAL IMPACT
Alaska OCS socioeconomic studies program. Technical report No. 43. Lower Cook Inlet and Shelikof Strait petroleum development scenarios. Final report, 5:23604 (PB—300701)
PETROLEUM INDUSTRY/SOLAR PROCESS HEAT
Application of solar energy for the generation and supply of industrial process low to intermediate pressure steam ranging in temperature from 300°F to 550°F, 5:23929 (SERI/TP—333-429)
PETROLEUM PRODUCTS
See also GASOLINE
LUBRICATING OILS
PETROLEUM PRODUCTS/ALLOCATIONS
Analysis of Federal Government energy emergency programs. Energy policy study, Volume 5. AR/EI-80-05, 5:24195 (DOE/EIA—0201/5)
PETROLEUM PRODUCTS/PRICING REGULATIONS
Analysis of Federal Government energy emergency programs. Energy policy study, Volume 5. AR/EI-80-05, 5:24195 (DOE/EIA—0201/5)
PETROLEUM REFINERIES/AIR POLLUTION CONTROL
A review of standards of performance for new stationary sources - petroleum refineries, 5:24638 (PB—300480)
PETROLEUM REFINERIES/HEAT RECOVERY EQUIPMENT
Potential industrial applications for fluidized-bed waste heat recovery systems, 5:24308 (DOE/CS/40255—1)
PETROLEUM REFINERIES/SOLAR PROCESS HEAT
Central receiver solar energy system for an oil refinery, 5:23917 (SERI/TP—333-429)
High temperature process steam application at the Southern Union Refining Company (solar energy in the oil patch), 5:23932 (SERI/TP—333-429)
PETROLEUM RESIDUES/COKING
Apparatus and method for controlling the rate of feeding a petroleum product to a coking drum system (Patent), 5:23591
Method of producing petroleum coke calcinate (Patent), 5:23592
PETROLEUM SULFONATES/PRECIPITATION
Precipitation of petroleum sulfonates by magnesium ions, 5:23578 (DOE/BETC/RI—80/3)
PHASE CHANGE MATERIALS/LATENT HEAT STORAGE
Analysis of energy storage by phase change with an array of cylindrical tubes, 5:23976
PHASE TRANSFORMATIONS
Equilibrium transition temperature of thermoelastic martensitic transformations, 5:24382
PHENOL/BIODEGRADATION
Environmentally acceptable disposal of coal conversion solid waste residuals. Progress report, April 21, 1979-July 31, 1979, 5:23458 (DOE/PC/20023—1)
PHENOL/DECOMPOSITION
Studies of phenolic compound decomposition under Synthane gasifier conditions. Final report, 5:23420 (FE—0208-T1)
PHENOLS
See also CRESOLS
PHENOL
PHENOLS/DECOMPOSITION
Studies of phenolic compound decomposition under Synthane gasifier conditions. Final report, 5:23420 (FE—0208-T1)
PHENOLS/REMOVAL
Treatment of waste water effluents from coal gasification units, 5:23434
PHI4-FIELD THEORY/ANHARMONIC OSCILLATORS
Orthogonal transforms and lattice field theories, 5:24878
PHOSPHATES/LATENT HEAT STORAGE
Heat transfer and calorimetric studies of a direct contact-latent heat energy storage system (Disodium hydrogen phosphate), 5:23977
PHOSPHORUS/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
PHOSPHORUS OXIDES/FABRICATION
NASICON: a new solid electrolyte for Na/S batteries, 5:24158
PHOSPHORUS SULFIDES/PHONONS
Temperature dependence of the phonon dispersion in Th_3PSe_4, 5:24466
PHOSPHORYLASES
See PHOSPHOTRANSFERASES
PHOSPHOTRANSFERASES/BIOCHEMICAL REACTION KINETICS
Assay of adenosine 3',5' cyclic monophosphate by stimulation of protein kinase: a method not involving radioactivity, 5:24672
Validation of conditions for efficient detection of HPRT and APRT mutations in suspension-cultured Chinese hamster ovary cells, 5:24710
PHOTOACOUSTIC EFFECT/MATHEMATICAL MODELS
Piezoelectric photoacoustic detection: Theory and experiment, 5:24575
PHOTOACOUSTIC EFFECT/RESOLUTION
High-resolution photoacoustic thermal-wave microscopy, 5:24577
PHOTOCHEMICAL REACTIONS
See also PHOTOSYNTHESIS
PHOTOCHEMICAL REACTIONS/BIOCHEMICAL REACTION KINETICS
Photoreversible absorbance changes in solutions of allophycocyanin purified from Fremyella diplosiphon: temperature dependence and quantum efficiency, 5:24677

PHOTOCHEMICAL REACTIONS/TEMPERATURE DEPENDENCE
Photoreversible absorbance changes in solutions of allophycocyanin purified from Fremyella diplosiphon: temperature dependence and quantum efficiency, 5:24677
PHOTOELASTICITY/THREE-DIMENSIONAL CALCULATIONS
Photoelastic studies of three-dimensional stress field caused by a cylindrical punch, 5:24532
PHOTOELECTROCHEMICAL CELLS/DESIGN
Photoelectrochemical cell (Patent), 5:23845
PHOTOELECTROCHEMICAL CELLS/ELECTRODES
Biological solar cell, 5:23844 (SERI/TP—623-656)
PHOTOEMISSION
(Photon-induced emission)
PHOTOEMISSION/ANGULAR DISTRIBUTION
Manifestation of dynamically unfavored transitions in the angular distribution of photofragments, 5:24831
PHOTOGRAPHS
See IMAGES
PHOTOGRAPHY/LIGHTING SYSTEMS
Novel photographic method of recording images from cellulose nitrate film, 5:24579
PHOTOGRAPHY/SOLAR PROCESS HEAT
Solar process water heat for the Iris Images Custom Color Photo Lab. Final report, 5:23904 (DOE/NASA/CR—161414)
PHOTOIONIZATION/ANGULAR DISTRIBUTION
Manifestation of dynamically unfavored transitions in the angular distribution of photofragments, 5:24831
PHOTOIONIZATION/CROSS SECTIONS
Enhanced photoexcitation from the surface of aluminum, 5:24409
PHOTOMETERS/PERFORMANCE
Differential light scattering photometer for rapid analysis of single particles in flow, 5:24576
PHOTON BEAMS/CALIBRATION
Absorbed dose measurements using parallel plate polystyrene ionization chambers in polystyrene phantoms, 5:24954
PHOTON DETECTION (GAMMA)
See GAMMA DETECTION
PHOTONS/ABSORPTION
Photon statistics in multiphoton absorption and emission processes, 5:24830
PHOTONS/EMISSION
Photon statistics in multiphoton absorption and emission processes, 5:24830
PHOTOSYNTHESIS/BIOCHEMICAL REACTION KINETICS
Ligated chlorophyll cation radicals: their function in photosystem II of plant photosynthesis, 5:24681
Photooxidation of antenna bacteriochlorophyll in chromatophores from carotenoidless mutant Rhodopseudomonas sphaeroides and the attendant loss of dimeric exciton interaction, 5:24682
Triplet states in photosystem I of spinach chloroplasts and subchloroplast particles, 5:24678
PHOTOSYNTHESIS/BIOLOGICAL PATHWAYS
Picosecond fluorescence studies of exciton migration and annihilation in photosynthetic systems. A review, 5:24693
PHOTOVOLTAIC CELLS
See also COMBINED COLLECTORS
SOLAR CELLS
PHOTOVOLTAIC CELLS/DESIGN
Photovoltaic cell comprising metal-free phthalocyanine (Patent), 5:23828
PHOTOVOLTAIC CELLS/EFFICIENCY
Photovoltaic cell comprising metal-free phthalocyanine (Patent), 5:23828
PHOTOVOLTAIC CELLS/FABRICATION
Preparation of thin films for solar energy utilization, 5:23825
PHOTOVOLTAIC CELLS/NATIONAL PROGRAM PLANS
Photovoltaic systems and applications perspective, 5:23820 (SAND—80-0926C)
PHOTOVOLTAIC POWER PLANTS
See also SOLAR CELL ARRAYS
PHOTOVOLTAIC POWER PLANTS/ENVIRONMENTAL IMPACTS
Climate and energy: a comparative assessment of the Satellite Power System (SPS) and alternative energy technologies, 5:23798 (DOE/ER—0050)
PHOTOVOLTAIC POWER PLANTS/HEALTH HAZARDS
Health and safety. Preliminary comparative assessment of the satellite power system (SPS) and other energy alternatives, 5:23847 (DOE/ER—0053)
PHOTOVOLTAIC POWER PLANTS/NET ENERGY
Comparative analysis of net energy balance for satellite power systems (SPS) and other energy systems, 5:23850 (DOE/ER—0056)
PHOTOVOLTAIC POWER SUPPLIES/DESIGN
Terrestrial photovoltaic design: a new experience in systems thinking, 5:23855
PHOTOVOLTAIC POWER SUPPLIES/ENERGY STORAGE SYSTEMS
Handbook for battery energy storage photovoltaic power systems. Final report, 5:23851 (SAN—2192-T1)
PHOTOVOLTAIC POWER SUPPLIES/FEASIBILITY STUDIES
Hybrid photovoltaic/thermal systems with a solar-assisted heat pump, 5:23876 (BNL—27667)
PHOTOVOLTAIC POWER SUPPLIES/PROCUREMENT
Photovoltaic procurement strategies: an assessment of supply issues, 5:23853 (SERI/TR—352-298)
PHOTOVOLTAIC POWER SUPPLIES/RESEARCH PROGRAMS
Photovoltaic systems and applications perspective, 5:23820 (SAND—80-0926C)
PHOTOVOLTAIC POWER SUPPLIES/SIMULATION
Design and performance of an 11 kW Solar Array Simulator, 5:23852 (SAND—80-0873C)
PHTHALOCYANINES/PHOTOCONDUCTIVITY
Photovoltaic cell (Patent), 5:23827
PHYCOCYANIN/PHOTOCHEMICAL REACTIONS
Photoreversible absorbance changes in solutions of allophycocyanin purified from Fremyella diplosiphon: temperature dependence and quantum efficiency, 5:24677
PIG ION SOURCES
See PENNING ION SOURCES
PIGMENTS
See also CHLOROPHYLL
CYTOCHROMES
HEME
PHYCOCYANIN
PIGMENTS/RAMAN SPECTRA
Time-resolved resonance Raman spectroscopy of intermediates of bacteriorhodopsin: the bK_{590} intermediate, 5:24685
PINS (FUEL)
See FUEL PINS
PION BEAMS/BEAM OPTICS
Investigation of a large solid angle pion channel for a medical application utilizing current sheets and solenoid elements, 5:24554 (LA—8356-MS)
PION DOSIMETRY
High LET dose measurements in patients undergoing pion radiotherapy, 5:24725
PION MINUS REACTIONS/CAPTURE
(π,p) absorption in /sup 6,7/Li at 75 and 175 MeV, 5:24889
Products of stopped-pion interactions with Cu and Ta, 5:24914
PION MINUS REACTIONS/CHARGE-EXCHANGE REACTIONS
(π,p) absorption in /sup 6,7/Li at 75 and 175 MeV, 5:24889
Interpretation of quasielastic pion scattering coincidence experiments, 5:24893
PION MINUS REACTIONS/INCLUSIVE INTERACTIONS
(π,p) absorption in /sup 6,7/Li at 75 and 175 MeV, 5:24889
PION MINUS REACTIONS/INELASTIC SCATTERING
Core polarization effects in inelastic pion-nucleus scattering (Glauber theory), 5:24947
PION MINUS REACTIONS/KNOCK-OUT REACTIONS
Interpretation of quasielastic pion scattering coincidence experiments, 5:24893
PION MINUS REACTIONS/QUASI-ELASTIC SCATTERING
Interpretation of quasielastic pion scattering coincidence experiments, 5:24893
PION MINUS-PROTON INTERACTIONS/CROSS SECTIONS
Leading particles and diffraction dissociation in 150-GeV/c π^- p interactions, 5:24854
PION MINUS-PROTON INTERACTIONS/DIFFRACTION MODELS
Leading particles and diffraction dissociation in 150-GeV/c π^- p interactions, 5:24854
PION MINUS-PROTON INTERACTIONS/LEADING PARTICLES
Leading particles and diffraction dissociation in 150-GeV/c π^- p interactions, 5:24854
PION PLUS REACTIONS/CAPTURE
(π,p) absorption in /sup 6,7/Li at 75 and 175 MeV, 5:24889
Products of stopped-pion interactions with Cu and Ta, 5:24914
PION PLUS REACTIONS/CHARGE-EXCHANGE REACTIONS
Interpretation of quasielastic pion scattering coincidence experiments, 5:24893
PION PLUS REACTIONS/INCLUSIVE INTERACTIONS
(π,p) absorption in /sup 6,7/Li at 75 and 175 MeV, 5:24889
PION PLUS REACTIONS/INELASTIC SCATTERING
Core polarization effects in inelastic pion-nucleus scattering (Glauber theory), 5:24947
PION PLUS REACTIONS/KNOCK-OUT REACTIONS
Interpretation of quasielastic pion scattering coincidence experiments, 5:24893

PION PLUS REACTIONS/QUASI-ELASTIC SCATTERING
Interpretation of quasielastic pion scattering coincidence experiments, 5:24893
PION PLUS-PROTON INTERACTIONS/BARYON-EXCHANGE MODELS
Search for narrow p-barp states in the reaction $\pi^+ p \rightarrow$ Δ/sub f/ $^{++}$ p-barp, 5:24852
PION PLUS-PROTON INTERACTIONS/ELASTIC SCATTERING
Search for narrow p-barp states in the reaction $\pi^+ p \rightarrow$ Δ/sub f/ $^{++}$ p-barp, 5:24852
PION PLUS-PROTON INTERACTIONS/SCATTERING AMPLITUDES
Measurement of radiative $\pi^+ p$ scattering below the $\Delta^{++}(1232)$ resonance, 5:24853
PION REACTIONS/CAPTURE
Pion absorption processes (32 to 74 MeV), 5:24896 (COO—3244-72)
PION-DEUTERON INTERACTIONS/MATHEMATICAL MODELS
Phenomenological relativistic quantum mechanics of the NNπ system, 5:24945
PION-DEUTERON INTERACTIONS/PARTICLE PRODUCTION
Investigation of higher-mass even-G states from 15-GeV/c $\pi^+ d$ collisions, 5:24855
PIONIC ATOMS/X-RAY SPECTRA
X-ray yields in protonium and mesic hydrogen, 5:24818
PION-NUCLEON INTERACTIONS/MATHEMATICAL MODELS
Phenomenological relativistic quantum mechanics of the NNπ system, 5:24945
PIONS
See also PIONS NEUTRAL
PIONS/BAG MODEL
Pion and an improved static bag model, 5:24870
PIONS/COHERENT PRODUCTION
Radiative width of the rho$^-$ meson, 5:24841
PIONS/COULOMB EXCITATION
Radiative width of the rho$^-$ meson, 5:24841
PIONS/PARTICLE PRODUCTION
Phenomenological relativistic quantum mechanics of the NNπ system, 5:24945
PIONS NEUTRAL/RADIATIVE DECAY
New upper limit for the C-noninvariant decay $\pi^0 \rightarrow 3\gamma$, 5:24843
PIPELINE QUALITY GAS
See HIGH BTU GAS
PIPES/REMOTE VIEWING EQUIPMENT
Unique rod lens/video system designed to observe flow conditions in emergency core coolant loops of pressurized water reactors, 5:24048 (UCRL—52902)
PIPES/STANDARDS
Nuclear standards transmittal, 5:24067 (RDT-M—3-34T(4-80)(Rev.))
PITCHES/TRANSPORT
Method of transporting liquid pitch containing lumpy cokes and apparatus therefor (Patent), 5:23606
PLACENTA/RADIONUCLIDE KINETICS
Cross-placental transfer of ^{243} ^{4}Cm in the baboon, 5:24759 (COO—3382-18)
PLANT CELLS/TEMPERATURE EFFECTS
Limits to life at low temperatures and at reduced water contents and water activities, 5:24702 (CONF-7810136—2)
PLANT GROWTH
Phytotoxicity and plant response to aqueous effluents derived from an in situ oil shale process water, 5:23664
PLANTS (INDUSTRIAL)
See INDUSTRIAL PLANTS
PLANTS (POWER)
See POWER PLANTS
PLASMA
See also BEAM-PLASMA SYSTEMS
COLLISIONLESS PLASMA
HOMOGENEOUS PLASMA
HOT PLASMA
LASER-PRODUCED PLASMA
SOLID-STATE PLASMA
PLASMA/ALFVEN WAVES
Stability of shear flow in a magnetized plasma, 5:25021
PLASMA/CHARGED-PARTICLE TRANSPORT
Computational methods for reversed-field equilibrium, 5:25018 (UCRL—84044(Rev.1))
PLASMA/EQUATIONS OF STATE
Improved equation of state for the classical one-component plasma, 5:24975
PLASMA/IONS
Propagation of light ions in a plasma channel, 5:24997
PLASMA/KINETIC EQUATIONS
Self similar solution of plasma equations, 5:25012
PLASMA/LASER RADIATION
Numerical analysis of high power laser propagation in magnetized plasmas, 5:25037
PLASMA/MAGNETIC FIELD REVERSAL
Computational methods for reversed-field equilibrium, 5:25018 (UCRL—84044(Rev.1))
PLASMA/RECOMBINATION
Measurement of effective ionization and recombination rate coefficients for intermediate iron ions in a laser generated theta-pinch heated plasma, 5:25008
PLASMA/THERMAL CONDUCTIVITY
Measurements of electron heat flow along a dc magnetic field in strong temperature gradients, 5:25013 (LA-UR—80-1109)
PLASMA/WAVE PROPAGATION
Propagation of light ions in a plasma channel, 5:24997
PLASMA ACCELERATION/HYDRODYNAMICS
Laser-plasma interaction and ablative acceleration of thin foils at 10^{13}—10^{15} W/cm^2, 5:25082
PLASMA CONFINEMENT
See also INERTIAL CONFINEMENT
PLASMA CONFINEMENT/BETA RATIO
Self-healing of confined plasmas with finite pressure, 5:24986
PLASMA DIAGNOSTICS/ENERGY-LEVEL TRANSITIONS
Probability distribution of ionized fragments following inner-shell-vacancy creation, 5:24996
PLASMA DIAGNOSTICS/LIGHT SCATTERING
Optimized method of measuring directed electron velocities using the the incoherent regions of laser scattering, 5:24998
PLASMA DIAGNOSTICS/NEUTRON SPECTRA
Measurement of the 2.35 MeV window in O + n, 5:24992 (CONF-791058—72)
PLASMA DIAGNOSTICS/THOMSON SCATTERING
Evaluation of a high power submillimeter pulsed laser system, 5:24993 (CONF-800138—1)
PLASMA DIAGNOSTICS/TIME-OF-FLIGHT METHOD
Low energy neutral outflux from the PLT Tokamak, 5:24994 (PPPL—1664)
UHV compatible chopper system, 5:25000
PLASMA DIAGNOSTICS/X-RAY SPECTROMETERS
Imaging system for obtaining space- and time-resolved plasma images on TMX, 5:24995 (UCRL—83805)
PLASMA DIAGNOSTICS/X-RAY SPECTROSCOPY
Soft x-ray imaging instrument for the Alcator A tokamak, 5:24999
PLASMA DRIFT/CHARGED-PARTICLE TRANSPORT
Guiding center drift equations, 5:25019
PLASMA DRIFT/GROWTH
Convective amplification of drift waves and thermal fluctuation levels in a stable plasma, 5:25040
PLASMA INSTABILITY
See also CONVECTIVE INSTABILITIES
PLASMA INSTABILITY/MAGNETOHYDRODYNAMICS
Local sufficient condition for magnetohydrodynamic stability of closed line systems, 5:25027
PLASMA PRODUCTION/ELECTRON-MOLECULE COLLISIONS
Production of plasma from diatomic gases by relativistic electron beams, 5:25022
PLASMA PRODUCTION/RELATIVISTIC BEAM INJECTION
Production of plasma from diatomic gases by relativistic electron beams, 5:25022
PLASMA SIMULATION/COMPUTER CODES
HLYWD: a program for post-processing data files to generate selected plots or time-lapse graphics, 5:25015 (ORNL/CSD/TM—109)
PLASMA SIMULATION/ONE-DIMENSIONAL CALCULATIONS
Randomness, Maxwellian distributions and resonance absorption, 5:24989
PLASMA WAVES
See also ION ACOUSTIC WAVES
Convective amplification of drift waves and thermal fluctuation levels in a stable plasma, 5:25040
Observations of plasma wave states, 5:25043
PLASMA WAVES/ELECTRON COLLISIONS
Method of evaluating the effects of particle scattering by fluctuations, 5:25039
PLASMA WAVES/ENERGY DENSITY
Wave-energy density and wave-momentum density of each speciesof a collisionless plasma, 5:25038
PLASMA WAVES/HYBRID RESONANCE
Current generation by unidirectional lower hybrid waves in the ACT-1 toroidal device, 5:25003 (PPPL—1662)
PLASMA WAVES/OSCILLATION MODES
Oscillations and waves in anisotropic plasmas, 5:25042
PLASMAPAUSE/AURORAL ZONES
Average parallel electric field deduced from the latitude and altitude variations of the perpendicular electric field below 8000 kilometers, 5:24803

PLASMAPAUSE/ELECTRIC FIELDS
Average parallel electric field deduced from the latitude and altitude variations of the perpendicular electric field below 8000 kilometers, 5:24803
PLASTER OF PARIS
See GYPSUM CEMENTS
PLASTIC FOAMS/PERFORMANCE TESTING
Cylinder overpack phenolic foam shock testing, 5:24518 (K/P—6567)
PLASTIC SCINTILLATION DETECTORS/CALIBRATION
Absolute calibration of a prompt gamma ray detector for intense bursts of protons, 5:24563 (NRL-MR—4171)
PLASTICITY/MATHEMATICAL MODELS
Use of endochronic plasticity for multi-dimensional small and large strain problems, 5:24385 (ANL-CT—79-19)
PLASTICS INDUSTRY/ECONOMIC ANALYSIS
Automotive manufacturers' cost/revenue, financial and risk analysis: projected impact of automobile manufacturing on the plastics industry. Final report June 1977-July 1978, 5:24181 (PB—300873)
PLASTICS INDUSTRY/RISK ASSESSMENT
Automotive manufacturers' cost/revenue, financial and risk analysis: projected impact of automobile manufacturing on the plastics industry. Final report June 1977-July 1978, 5:24181 (PB—300873)
PLATES
(Thicker than SHEETS or FOILS.)
PLATES/EDDY CURRENTS
Eddy current heating of irregularly shaped plates by slow ramped fields, 5:25048 (CONF-791102—167)
PLATINUM/CATALYTIC EFFECTS
Hydroprocessing of hydrocarbons over nickel, moly, platinum catalyst (Patent), 5:23593
Removal of tritium and tritium-containing compounds from a gaseous stream (Patent), 5:23764
PLATINUM/SORPTIVE PROPERTIES
Low energy electron diffraction (LEED) study of the adsorption of acetic acid and propanoic acid on Ag(111) and Pt(111), 5:24406
PLATINUM 195 TARGET/NEUTRON REACTIONS
Level structure of ^{196}Pt, 5:24932
PLATINUM 196/ENERGY LEVELS
Level structure of ^{196}Pt, 5:24932
PLT DEVICES
(Princeton Large Torus.)
PLT DEVICES/BEAM INJECTION
ISX-B neutral beam injector experiment on a prototype beam line, 5:24987
PLT DEVICES/IMPURITIES
Probe measurements of impurities in the plasma boundary of PLT, 5:25004 (SAND—79-2338C)
PLT DEVICES/PLASMA DIAGNOSTICS
Low energy neutral outflux from the PLT Tokamak, 5:24994 (PPPL—1664)
PLUGS
See CLOSURES
PLUTONIUM/COLLISIONS
AES and XPS study of plutonium oxidation, 5:24415
PLUTONIUM/ION EXCHANGE
Kilogram-scale purification of americium by ion exchange, 5:23703 (PNL-SA—7844)
PLUTONIUM/MUONIC ATOMS
Actinide muonic atom lifetimes deduced from muon-induced fission, 5:24937
PLUTONIUM/OXIDATION
AES and XPS study of plutonium oxidation, 5:24415
PLUTONIUM/PURIFICATION
Plutonium recovery at the Los Alamos Scientific Laboratory, 5:23720 (LA-UR—80-1168)
PLUTONIUM/TITRATION
Modified titrimetric determination of plutonium using photometric end-point detection, 5:24486 (LA—8145)
PLUTONIUM 238/GENETIC RADIATION EFFECTS
Mutagenicity and cytotoxicity of 4.4-MeV α particles emitted by plutonium-238, 5:24739
PLUTONIUM 238/RADIOECOLOGICAL CONCENTRATION
Distribution of ^{239,240}Pu, ^{238}Pu, and ^{137}Cs in various particle size classes of Lake Michigan sediments, 5:24655
PLUTONIUM 239/CARCINOGENESIS
Osteosarcomas among beagles exposed to ^{239}Plutonium. Technical report No. 34, 5:24751 (DOE/EV/02874—68)
PLUTONIUM 239/RADIOECOLOGICAL CONCENTRATION
Distribution of ^{239,240}Pu, ^{238}Pu, and ^{137}Cs in various particle size classes of Lake Michigan sediments, 5:24655
PLUTONIUM 239 TARGET/MUON REACTIONS
Actinide muonic atom lifetimes deduced from muon-induced fission, 5:24937
PLUTONIUM 240/RADIOECOLOGICAL CONCENTRATION
Distribution of ^{239,240}Pu, ^{238}Pu, and ^{137}Cs in various particle size classes of Lake Michigan sediments, 5:24655
PLUTONIUM 242 TARGET/MUON REACTIONS
Actinide muonic atom lifetimes deduced from muon-induced fission, 5:24937
PLUTONIUM CARBIDES/THERMAL CONDUCTIVITY
Thermal conductivities of mixed carbide fuel and blanket materials, 5:24058 (LA-UR—80-1283)
PLUTONIUM CARBIDES/THERMAL DIFFUSIVITY
Thermal conductivities of mixed carbide fuel and blanket materials, 5:24058 (LA-UR—80-1283)
PLUTONIUM ISOTOPES/GAMMA SPECTROSCOPY
Determination of plutonium isotopic content by passive gamma spectrometric methods, 5:24490 (RFP—3090)
PNA
See POLYCYCLIC AROMATIC HYDROCARBONS
POINT CONTACTS
See ELECTRIC CONTACTS
POINT MUTATIONS
See GENE MUTATIONS
POISEUILLE FLOW
See LAMINAR FLOW
POLIO VIRUS/INFECTIVITY
Modified procedure for the recovery of naturally accumulated poliovirus from oysters, 5:24727
POLLEN/AEROSOL MONITORING
Airborne aeroallergen measurements in Houston, Texas. Final report, 5:24602 (PB—299643)
POLLUTION CONTROL
See also AIR POLLUTION CONTROL
Demonstrating the noise control of a coal preparation plant. Volume I. Initial installation and treatment evaluation. Open file report (final), 5:23524 (PB—299963)
POLLUTION CONTROL/RESEARCH PROGRAMS
Bibliography of the Interagency Energy/Environment R and D Program, 5:24593 (EPA—600/9-79-015)
Fiscal Year 1977 Research Program Abstracts of the Interagency Energy/Environment R & D Program, 5:24594 (EPA—600/9-79-016)
POLLUTION CONTROL/TECHNOLOGY ASSESSMENT
Treatment of waste water effluents from coal gasification units, 5:23434
POLLUTION CONTROL EQUIPMENT
See also AIR FILTERS
CATALYTIC CONVERTERS
ELECTROSTATIC PRECIPITATORS
SCRUBBERS
POLLUTION CONTROL EQUIPMENT/BIBLIOGRAPHIES
Nitrogen oxide air pollution. Part 1. Control technology. volume 2. 1975-1977 (a bibliography with abstracts). Report for 1975-77, 5:24545 (NTIS/PS—79/1056)
Nitrogen oxide air pollution. Part 1. Control technology. Volume 3, 1978-August, 1979 (a bibliography with abstracts). Report for 1978-August 1979, 5:24546 (NTIS/PS—79/1057)
POLLUTION CONTROL EQUIPMENT/COST
Effectiveness and cost of air pollution control for coal-fired electric power plants in the west, 5:24037 (PB—300515)
POLLUTION CONTROL EQUIPMENT/INSPECTION
An analysis of inspection-maintenance program options for Jefferson County, Kentucky. executive summary. Final report, 5:24606 (PB—299935)
Questions and answers concerning the technical details of inspection and maintenance. Technical report, 5:24354 (PB—301215)
POLLUTION CONTROL EQUIPMENT/PERFORMANCE
Effectiveness and cost of air pollution control for coal-fired electric power plants in the west, 5:24037 (PB—300515)
Impact of ammonia utilization by NOx flue gas treatment processes. Final report August 1977-November 1978, 5:24038 (PB—300596)
POLLUTION CONTROL EQUIPMENT/TECHNOLOGY ASSESSMENT
Environmental assessment of stationary source NOx control technologies. Annual report no. 2, June 1977-June 1978, 5:24547 (PB—300469)
POLLUTION LAWS/COMPLIANCE
Compliance status of major air pollution facilities. Final report, 5:24636 (PB—299959)
POLLUTION LAWS/SOCIO-ECONOMIC FACTORS
Balancing the objectives of clean air and economic growth: regulated markets in emission reductions. Interim report, 5:24639 (PB—300835)
POLORIDAL DIVERTOR EXPERIMENT
See PDX DEVICES
POLYCYCLIC AROMATIC HYDROCARBONS/MEASURING METHODS
Room temperature phosphorimetry for the analysis of environmental systems, 5:24651 (CONF-791059—8)

POLYESTERS/CHEMICAL REACTION YIELD
Synthesis of thermosetting polymers from the by-products of coal conversion processes, 5:23450
POLYESTERS/CURING
Synthesis of thermosetting polymers from the by-products of coal conversion processes, 5:23450
POLYETHYLENES/GAMMA SPECTRA
Integral experiments for fusion reactor design: analysis, 5:25084 (CONF-791058—74)
POLYETHYLENES/NEUTRON SPECTRA
Integral experiments for fusion reactor design: analysis, 5:25084 (CONF-791058—74)
POLYMER FLOODING
See MICROEMULSION FLOODING
POLYMERASES/ENZYME ACTIVITY
Fidelity of fractionated deoxyribonucleic acid polymerases from human placenta, 5:24696
POLYMERASES/FRACTIONATION
Fidelity of fractionated deoxyribonucleic acid polymerases from human placenta, 5:24696
POLYMERS
See also ORGANIC POLYMERS
SILICONES
POLYMERS/COMBUSTION
Polymer combustion mechanisms, 5:24450 (EPRI-EL—1263)
Special reporter comments and questions, 5:24441 (EPRI-EL—1263)
POLYMERS/ELECTRICAL PROPERTIES
Fire retardant polymers in electrical wire and cable, 5:24449 (EPRI-EL—1263)
POLYMERS/FABRICATION
Polymer concrete composites for the production of high strength pipe and linings in high temperature corrosive environments (Patent), 5:24444
POLYMERS/FIRE RESISTANCE
Measurement and meaning of flame retardancy, 5:24442 (EPRI-EL—1263)
Review of the approaches to improving the flame resistance of wire and cable insulating and jacketing materials, 5:24447 (EPRI-EL—1263)
POLYMERS/FIRES
Cable tray fire tests, 5:24446 (EPRI-EL—1263)
POLYMERS/OXIDATION
Polymer combustion mechanisms, 5:24450 (EPRI-EL—1263)
POLYMERS/POLYMERIZATION
High temperature chemically resistant polymer concrete (Patent), 5:24443
POLYMERS/PRODUCTION
High temperature chemically resistant polymer concrete (Patent), 5:24443
POLYMERS/QUALITY CONTROL
Use of x-ray fluorescence spectral analysis in material characterization for quality control, 5:24531 (EPRI-EL—1263)
POLYMERS/TESTING
Cable tray fire tests, 5:24446 (EPRI-EL—1263)
POLYNUCLEAR HYDROCARBONS
See CONDENSED AROMATICS
POLYVINYLS
See also PVC
PVP
POLYVINYLS/CHEMICAL PREPARATION
Heat and chemically resistant membranes, 5:24166
PONDS
See also COOLING PONDS
SOLAR PONDS
Field retention time studies of ash settling ponds, 5:23474 (METC/SP—79/10(Pt.1))
PONDS/ENVIRONMENTAL IMPACTS
Environmental sampling program for a solar evaporation pond for liquid radioactive wastes, 5:23729 (LA—8177)
PONDS/TRACER TECHNIQUES
Fly ash ponds, 5:23473 (METC/SP—79/10(Pt.1))
PONDS (COOLING)
See COOLING PONDS
POOR PEOPLE
See LOW INCOME GROUPS
POPULATION DYNAMICS/BIOLOGICAL MODELS
Size and pattern of simulated forest stands, 5:24669
POPULATION DYNAMICS/MATHEMATICAL MODELS
Study of mathematical models of mutation and selection in multi-locus systems. Annual progress report, April 1, 1979-March 31, 1980, 5:24667 (DOE/EV/02472—6)
POROUS MATERIALS/STRESSES
Constitutive equation for porous materials with strength, 5:24387
POSITIVE IONS
See CATIONS
POTABLE WATER
See DRINKING WATER
POTASSIUM/ATOM-MOLECULE COLLISIONS
Collisional ionization of Cs and K by O_2, 5:24823
POTASSIUM/CHEMICAL BONDS
Microscopic theory of thermal desorption and dissociation processes catalyzed by a solid surface, 5:24959
POTASSIUM/DENSITY
Extension of liquid-metal theory to dense partially ionized plasmas, 5:24834
POTASSIUM/EMISSION SPECTRA
Splitting of surface-plasmon emission spectra from potassium, 5:24412
POTASSIUM/EMISSION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
POTASSIUM/GAMMA SPECTROSCOPY
Investigations of the uranium potential along the Proterozoic unconformity in the Van Horn Areas, Texas. Final report, 5:23688 (GJBX—97(80))
POTASSIUM/SORPTIVE PROPERTIES
Microscopic theory of thermal desorption and dissociation processes catalyzed by a solid surface, 5:24959
POTASSIUM/SURFACES
Splitting of surface-plasmon emission spectra from potassium, 5:24412
POTASSIUM/THERMODYNAMIC PROPERTIES
Extension of liquid-metal theory to dense partially ionized plasmas, 5:24834
POTASSIUM COMPOUNDS/CORROSIVE EFFECTS
Nickel-iron alloy corrosion in a sealed pyrotechnic system, 5:24413 (MLM—2707(OP))
POTASSIUM COMPOUNDS/FABRICATION
Shock compaction of a porous pyrotechnic material, 5:24430 (SAND—80-0427C)
POTASSIUM COMPOUNDS/IONIC CONDUCTIVITY
Computer-simulated hopping in a random one-dimensional system, 5:24472
POTASSIUM COMPOUNDS/PRODUCTION
Preparation of hydrosulfides (Patent), 5:24456
POTASSIUM NITRATES/PHASE DIAGRAMS
Phase diagram of $NaNO_3/KNO_3$, 5:24458 (SAND—80-8502)
POTATOES/FOOD PROCESSING
Potato processing, 5:24000
POTATOES/SOLAR COOKING
Solar production of industrial process steam for potato frying, 5:23935 (SERI/TP—333-429)
POWER CONDITIONING CIRCUITS/RESEARCH PROGRAMS
Power conditioners and fuel cell inverters, 5:24242
POWER DEMAND/PUBLIC OPINION
An investigation of preferences for various types of energy cost feedback. Final report, 5:24212 (PB—300314)
POWER DEMAND/TIME-OF-USE PRICING
Electricity demand and consumption by time-of-use: a survey. Final report, 5:24197 (EPRI-AF—1294)
POWER GENERATION
See also CO-GENERATION
POWER GENERATION/GEOTHERMAL FLUIDS
Air pressure differential energy system (Patent), 5:24014
POWER GENERATION/PRESSURE GRADIENTS
Air pressure differential energy system (Patent), 5:24014
POWER GENERATION/SOLAR AIR HEATERS
Air pressure differential energy system (Patent), 5:24014
POWER GENERATION/SOLAR WATER HEATERS
Air pressure differential energy system (Patent), 5:24014
POWER GENERATION/TECHNOLOGY ASSESSMENT
Generating technology assessment. Phase I work plan, Task 1 report, 5:24006 (DOE/EIA/10480—T1)
POWER METERS/PERFORMANCE
An investigation of preferences for various types of energy cost feedback. Final report, 5:24212 (PB—300314)
POWER PLANT AND INDUSTRIAL FUEL USE ACT/IMPLEMENTATION
Powerplant and Industrial Fuel Use Act: annual report, 5:24203 (DOE/RG—0028)
POWER PLANTS
See also FUEL CELL POWER PLANTS
GAS TURBINE POWER PLANTS
MHD POWER PLANTS
THERMAL POWER PLANTS
THERMONUCLEAR POWER PLANTS
POWER PLANTS/CONTROL SYSTEMS
Assessment of new instrumentation and control technologies. Remote multiplexing. A case study, 5:24077
POWER PLANTS/DESIGN
Solid fuel fired gas turbine system having continuously regenerating granular filter (Patent), 5:24020
POWER PLANTS/ELECTRIC CABLES
Minimizing fire potential in power plant cable systems, 5:24074 (EPRI-EL—1263)

POWER PLANTS/ENVIRONMENTAL IMPACTS
Marine fisheries review, volume 41, number 3, March 1979, 5:24656 (PB—300280)
POWER PLANTS/FINANCIAL INCENTIVES
Powerplant productivity improvement study: policy analysis and incentive assessment. Final report, 5:24210 (CONS—8138-T1)
POWER PLANTS/GRANULAR BED FILTERS
Solid fuel fired gas turbine system having continuously regenerating granular filter (Patent), 5:24020
POWER PLANTS/INFORMATION VALIDATION
Note on the robustness of Dixon's ratio test in small samples (Testing for outliers), 5:25111 (ORNL/TM—7265)
POWER PLANTS/LAND REQUIREMENTS
Preliminary comparative assessment of land use for the satellite power system (SPS) and alternative electric energy technologies, 5:23848 (DOE/ER—0054)
POWER PLANTS/PRODUCTIVITY
Powerplant productivity improvement study: policy analysis and incentive assessment. Final report, 5:24210 (CONS—8138-T1)
POWER PLANTS/REGULATIONS
Powerplant productivity improvement study: policy analysis and incentive assessment. Final report, 5:24210 (CONS—8138-T1)
POWER PLANTS/THERMAL POLLUTION
Entrainment, 5:24761
POWER POOLS
See INTERCONNECTED POWER SYSTEMS
POWER REACTORS
See also BOR-60 REACTOR
CLINCH RIVER BREEDER REACTOR
EBR-2 REACTOR
INDIAN POINT-2 REACTOR
N-REACTOR
THREE MILE ISLAND-2 REACTOR
POWER REACTORS/PIPES
Nuclear standards transmittal, 5:24067 (RDT-M—3-34T(4-80)(Rev.))
POWER REACTORS/REACTOR KINETICS
Solving the nuclear reactor core problems, 5:24071 (CONF-791186—1)
POWER REACTORS/TUBES
Nuclear standards transmittal, 5:24067 (RDT-M—3-34T(4-80)(Rev.))
Nuclear standards transmittal, 5:24068 (RDT-M—3-4T(4-80)(Rev.))
POWER SUBSTATIONS/DESIGN
Conceptual design of electrical balance of plant for advanced battery energy storage facility. Annual report, March 1979, 5:24155 (ANL—80-16)
POWER SUPPLIES
See also PHOTOVOLTAIC POWER SUPPLIES
RADIO EQUIPMENT POWER SUPPLIES
SPACECRAFT POWER SUPPLIES
POWER SUPPLIES/DESIGN
1000-kVA arc power supply, 5:25052 (CONF-791102—166)
POWER SUPPLIES/TEXT DEVICES
Contacts for pulsed high current: design and test, 5:25053
POWER SYSTEMS
See also DC SYSTEMS
INTERCONNECTED POWER SYSTEMS
POWER SYSTEMS/FEASIBILITY STUDIES
Study of the feasibility of linking the islands of Maui, Molokai, and Lanai with submarine electrical power cables, 5:24039 (HNEI—7902)
POWER TRANSMISSION LINES/CONSTRUCTION
Study of the feasibility of linking the islands of Maui, Molokai, and Lanai with submarine electrical power cables, 5:24039 (HNEI—7902)
POWER TRANSMISSION LINES/COST
Study of the feasibility of linking the islands of Maui, Molokai, and Lanai with submarine electrical power cables, 5:24039 (HNEI—7902)
POWER TRANSMISSION LINES/LAND REQUIREMENTS
Study of the feasibility of linking the islands of Maui, Molokai, and Lanai with submarine electrical power cables, 5:24039 (HNEI—7902)
PRESSURE MEASUREMENT/MEASURING INSTRUMENTS
Bell Canyon Test (BCT) instrumentation development, 5:24571 (SAND—80-0408C)
PRESSURE VESSELS/CLEANING
Review of the wall problem and conditioning techniques for tokamaks, 5:25091 (PPPL—1666)
PRESSURE VESSELS/CRACKS
Use of acoustic emission for assessing the integrity of a nuclear reactor pressure vessel, 5:24392
PRESSURE VESSELS/MATERIALS
Design properties of steels for coal conversion vessels. Interim report, 5:23419 (EPRI-AF—1242)
PRESSURE VESSELS/NOZZLES
Determination of K-factors for arbitrarily shaped flaws at pressure vessel nozzle corners, 5:24045 (CONF-791118—11)
PRESSURE VESSELS/QUALITY ASSURANCE
Users manual data base MATSURV. Reactor pressure vessel material surveillance data management system, 5:24072 (ALO—63)
PRESSURE VESSELS/REFRACTORIES
Test and evaluate the TRI-GAS low-Btu coal gasification process. Quarterly report, January-March 1980, 5:23418 (DOE/ET/10254—T2)
PRESSURE VESSELS/SAFETY STANDARDS
Pressure vessel safety: the story of the ASME code, 5:24533
PRESSURIZED WATER REACTORS
See PWR TYPE REACTORS
PRIMARY BATTERIES/ANODES
Passivating layer on lithium in lithium tetrachloroaluminate-$SOCl_2$ solutions, 5:24170
PRIMARY BATTERIES/CATHODES
FeS/Li organic electrolyte cell (1.25 to 1.4 V, 60 to 83 mAh/g), 5:24118
Latex bonded lead dioxide reserve electrode, 5:24162
Lithium thionyl chloride high rate reserve cells, 5:24121
PRIMARY BATTERIES/CHEMICAL REACTIONS
Chemistry of the Li/SO_2 battery: a review, 5:24143
Li/SO_2 cells of improved stability, 5:24141
Primary Li/$SOCl_2$ cells. VI. Identification of the possible explosion causing cell constituents by DTA studies, 5:24152
PRIMARY BATTERIES/CORROSION INHIBITORS
Corrosion: a major failure mode of Li/V_2O_5 cells, 5:24146
PRIMARY BATTERIES/DESIGN
Development of subminiature lithium-monofluorographite-organic electrolyte primary cells (60 MWh), 5:24117
Lithium/thionyl chloride reserve cell development (1/2 Ah), 5:24120
PRIMARY BATTERIES/ELECTROCHEMICAL CORROSION
Corrosion: a major failure mode of Li/V_2O_5 cells, 5:24146
PRIMARY BATTERIES/ELECTROCHEMISTRY
Chemistry of the Li/SO_2 battery: a review, 5:24143
Effects of the electrochemical design upon the safety and performance of the lithium-sulfur dioxide cells, 5:24168
Lithium-manganese dioxide cell (30 mAh to 5 Ah), 5:24145
PRIMARY BATTERIES/ELECTRODES
Effects of the electrochemical design upon the safety and performance of the lithium-sulfur dioxide cells, 5:24168
PRIMARY BATTERIES/ELECTROLYTES
FeS/Li organic electrolyte cell (1.25 to 1.4 V, 60 to 83 mAh/g), 5:24118
Lithium thionyl chloride high rate reserve cells, 5:24121
Stability of the $LiAsF_6$:An:SO_2 electrolyte, 5:24169
Thionyl chloride electrolytes containing $B_{10}Cl_{10}^{--}$ and $B^{12}Cl_{12}^{--}$, 5:24171
PRIMARY BATTERIES/EXPLOSIONS
Analysis of Li/SO_2 system safety, 5:24142
PRIMARY BATTERIES/HEATING
Use of microcalorimetry in characterization of lithium pacemaker batteries (Lithium/iodine polyvinyl pyridine cells), 5:24148
PRIMARY BATTERIES/MANUFACTURING
Manufacturing techniques for hermetically sealed lithium organic electrolyte cells, 5:24116
PRIMARY BATTERIES/MEETINGS
Twenty-eighth power sources symposium (Atlantic City, NJ, June 12-15, 1978), 5:24102
PRIMARY BATTERIES/PERFORMANCE
Large lithium-thionyl chloride cells: cell performance and safety (1.6 to 11,000 Ah), 5:24151
Applications of the lithium/carbon mono-fluoride battery (600 mAh to 25 Ah), 5:24144
Development of subminiature lithium-monofluorographite-organic electrolyte primary cells (60 MWh), 5:24117
Effects of the electrochemical design upon the safety and performance of the lithium-sulfur dioxide cells, 5:24168
FeS/Li organic electrolyte cell (1.25 to 1.4 V, 60 to 83 mAh/g), 5:24118
Li/SO_2 cells of improved stability, 5:24141
Lithium-manganese dioxide cell (30 mAh to 5 Ah), 5:24145
Lithium/thionyl chloride reserve cell development (1/2 Ah), 5:24120
Lithium thionyl chloride high rate reserve cells, 5:24121
PRIMARY BATTERIES/PERFORMANCE TESTING
Analysis of Li/SO_2 system safety, 5:24142
Evaluation of zinc/silver chloride batteries after 10 years storage, 5:24129
Field tests with lithium/SO_2 batteries, 5:24140
Five year storage tests of solid state Ag/I_2 batteries, 5:24130
Li/$SOCl_2$ cell as an effective power source (Approx. 1.9 Ah), 5:24149
Performance characteristics of large primary Li/$SOCl_2$ cells (2000 and 10,000 Ah), 5:24150

Properties of the LiCuO couple (1.5 V, 3.42 Ah and 4.24 Wh at 20°C through 120 Ω load), 5:24147
PRIMARY BATTERIES/SAFETY
Safety aspects of Li/$SOCl_2$ batteries (4 to 14 Ah), 5:24153
PRIMARY BATTERIES/SPECIFICATIONS
Lithium-manganese dioxide cell (30 mAh to 5 Ah), 5:24145
PRIMARY BATTERIES/TESTING
Safety aspects of Li/$SOCl_2$ batteries (4 to 14 Ah), 5:24153
PRINCETON LARGE TORUS
See PLT DEVICES
PROBES/DESIGN
Portable probe to measure sensitization of stainless steel (Patent), 5:24417
PROCESS SOLUTIONS/ELECTRODIALYSIS
Technical and economic feasibility of membrane technology. Technical progress report, December 17, 1979-March 16, 1980, 5:23834 (BSDF—39-2Q-80)
PROCESS SOLUTIONS/MONITORING
Environmental assessment of coal cleaning processes; master test plan. Final report June 1977-January 1979, 5:24652 (PB—300670)
PROCESS SOLUTIONS/OSMOSIS
Technical and economic feasibility of membrane technology. Technical progress report, December 17, 1979-March 16, 1980, 5:23834 (BSDF—39-2Q-80)
PROCESS SOLUTIONS/ULTRAFILTRATION
Technical and economic feasibility of membrane technology. Technical progress report, December 17, 1979-March 16, 1980, 5:23834 (BSDF—39-2Q-80)
PROCESS SOLUTIONS/WATER POLLUTION
Environmental assessment of coal cleaning processes; master test plan. Final report June 1977-January 1979, 5:24652 (PB—300670)
PROCESSING (DATA)
See DATA PROCESSING
PROCESSING (ORES)
See ORE PROCESSING
PROCESSING (WASTES)
See WASTE PROCESSING
PROCUREMENT/PROFESSIONAL PERSONNEL
Department of Energy Procurement and Financial-Assistance Career Guide, 5:24173 (DOE/PR—0038)
PROFESSIONAL PERSONNEL/DECISION MAKING
Assessment of effectiveness of geologic isolation systems: the feasibility of computer interrogation of experts for WISAP, 5:23736 (PNL—2862)
Remarks on the assessment, representation, aggregation and utilization of expert opinion, 5:23749 (UCID—18665)
PROFESSIONAL PERSONNEL/EDUCATION
Department of Energy Procurement and Financial-Assistance Career Guide, 5:24173 (DOE/PR—0038)
PROGRAMMING/COMPUTER-AIDED DESIGN
Concurrent software system design supported by SARA at the age of one, 5:25102
SARA aided design of software for concurrent systems, 5:25103
PROPANOLS/ADSORPTION
Low energy electron diffraction (LEED) study of the adsorption of acetic acid and propanoic acid on Ag(111) and Pt(111), 5:24406
PROPANONE
See ACETONE
PROPELLANTS/COMBUSTION
Modeling propellant combustion interacting with an eroding solid surface, 5:24584 (UCRL—83727)
PROSTAGLANDINS/BIOLOGICAL EFFECTS
Comparison of the effects of prostaglandin E_2 and parathyroid hormone on plasma calcium concentration and osteoclast function, 5:24698
PROTECTION (RADIATION)
See RADIATION PROTECTION
PROTEINS
See also ACTIN
GLOBIN
GLUCOPROTEINS
LIPOPROTEINS
PROTEINS/BIOASSAY
Biochemical studies of mouse brain tubulin: colchicine binding (DEAE-cellulose filter) assay and subunits (α and β) biosynthesis and degradation (in newborn brain), 5:24695 (UR—3490-1559)
PROTEINS/BIOSYNTHESIS
Biochemical studies of mouse brain tubulin: colchicine binding (DEAE-cellulose filter) assay and subunits (α and β) biosynthesis and degradation (in newborn brain), 5:24695 (UR—3490-1559)
Reproductive survival and macromolecular synthesis in cultured mammalian cells exposed to single metabolites and mixtures of metabolites of benzo(a)pyrene, 5:24762 (CONF-791059—6)
PROTEINS/CATABOLISM
Biochemical studies of mouse brain tubulin: colchicine binding (DEAE-cellulose filter) assay and subunits (α and β) biosynthesis and degradation (in newborn brain), 5:24695 (UR—3490-1559)
PROTEINS/ELECTROPHORESIS
Analytical techniques for cell fractions, 5:24674
PROTEINS/ENZYME REACTIVATION
Effect of the composition of sodium dodecyl sulfate preparations on the renaturation of enzymes after polyacrylamide gel electrophoresis, 5:24675
PROTEINS/PURIFICATION
Purification of two spectrin-binding proteins: biochemical and electron microscopic evidence for site-specific reassociation between spectrin and bands 2.1 and 4.1, 5:24704
PROTEINS/STRUCTURAL CHEMICAL ANALYSIS
Analytical techniques for cell fractions. XXVII. Use of heart proteins as reference standards in two-dimensional electrophoresis, 5:24673
PROTEOLIPIDS
See LIPOPROTEINS
PROTON DETECTION/SPARK COUNTERS
New particle detector: a spark counter with localized discharge, 5:24564
PROTON REACTIONS/ELASTIC SCATTERING
Asymmetry in total scattering of polarized protons by nuclei at 2.1 GeV/s, 5:24839 (LA-tr—80-12)
Proton-deuteron elastic scattering at 800 MeV, 5:24891
PROTON REACTIONS/INELASTIC SCATTERING
800-MeV inelastic proton scattering from ^{40}Ca, ^{48}Ca, and ^{54}Fe, 5:24911
Asymmetry in total scattering of polarized protons by nuclei at 2.1 GeV/s, 5:24839 (LA-tr—80-12)
PROTON REACTIONS/PICKUP REACTIONS
W(p,t) reactions. I. Even targets, 5:24924
W(p,t) reactions. II. Odd target, 5:24925
PROTONIUM/LEVEL WIDTHS
X-ray yields in protonium and mesic hydrogen, 5:24818
PROTONIUM/SPECTRAL SHIFT
X-ray yields in protonium and mesic hydrogen, 5:24818
PROTONIUM/X-RAY SPECTRA
X-ray yields in protonium and mesic hydrogen, 5:24818
PROTON-NUCLEON INTERACTIONS
See also PROTON-PROTON INTERACTIONS
PROTON-NUCLEON INTERACTIONS/PARTICLE PRODUCTION
Observation of hadronic charm production in a high resolution streamer chamber experiment, 5:24851
PROTON-PROTON INTERACTIONS/INCLUSIVE INTERACTIONS
Recombination model and multimeson production, 5:24869
PROTON-PROTON INTERACTIONS/MULTIPLE PRODUCTION
Recombination model and multimeson production, 5:24869
PROTON-PROTON INTERACTIONS/PHASE SHIFT
Optimized polynomial expansions: potentials and phase shift analyses, 5:24871 (DOE/ER/10516—T3)
PROTON-PROTON INTERACTIONS/SCATTERING AMPLITUDES
New optimal polynomial theory for NN-scattering, 5:24844 (DOE/ER/10516—T2)
Optimized polynomial expansions: potentials and phase shift analyses, 5:24871 (DOE/ER/10516—T3)
PROTONS/BIOLOGICAL RADIATION EFFECTS
Calculation of ionization frequency distributions in small sites, 5:24722
PROTONS/PARTICLE PRODUCTION
Recent results from the Mark II detector at SPEAR, 5:24837
Search for narrow p-barp states in the reaction $\pi^+ p \rightarrow \Delta/sub\ f/^{++}$ p-barp, 5:24852
PROTOPLASTS
See PLANT CELLS
PROTOSTARS/GRAVITATIONAL COLLAPSE
Formation of solar-type stars in spherical symmetry. I. The key role of the accretion shock, 5:24794
PROTOSTARS/STAR ACCRETION
Formation of solar-type stars in spherical symmetry. I. The key role of the accretion shock, 5:24794
PSI RESONANCES/PARTICLE DECAY
Measurement of γγpsi final states in psi' decay, 5:24840
PSI RESONANCES/RADIATIVE DECAY
Decay $J/\pi \rightarrow 3\gamma$ and a search for the eta/sub c/, 5:24842
Recent results from the crystal ball detector at SPEAR, 5:24838
PSI-3695 RESONANCES/PARTICLE PRODUCTION
Recent results from the Mark II detector at SPEAR, 5:24837
PUBLIC BUILDINGS/ENERGY CONSERVATION
Energy conservation and management guide for small municipalities and school districts, 5:24261 (PB—300223)

PUBLIC BUILDINGS/GEOTHERMAL SPACE HEATING
Evaluation of city well 1, Klamath Falls, Oregon, 5:23999 (LBL—10848)
PUBLIC BUILDINGS/SOLAR SPACE HEATING
Using a collector 24 hours a day (County jail), 5:23895
PUBLIC BUILDINGS/SOLAR WATER HEATING
Using a collector 24 hours a day (County jail), 5:23895
PUBLIC BUILDINGS/WASTE HEAT UTILIZATION
Using a collector 24 hours a day (County jail), 5:23895
PUBLIC HEALTH/DATA BASE MANAGEMENT
Spatial data on energy, environmental, health, and socio-economic themes at Oak Ridge National Laboratory: 1979 inventory, 5:24175 (ORNL—5636)
PUBLIC UTILITIES
See also ELECTRIC UTILITIES
PUBLIC UTILITIES/CAPACITY
Literature review on capacity expansion planning under uncertainty. Phase II, 5:24211 (DOE/TIC—11177)
PUBLIC UTILITIES/INVESTMENT
Literature review on capacity expansion planning under uncertainty. Phase II, 5:24211 (DOE/TIC—11177)
PUBLIC UTILITY REGULATORY POLICIES ACT/SOLAR ENERGY
Analysis of PURPA and solar energy, 5:23799 (SERI/TR—434-484)
PULPS
See SLURRIES
PULSE GENERATORS/DESIGN
Status of the upgraded version of the NRL GAMBLE II pulse power generator, 5:25054
PULSE GENERATORS/MAGNETIC ENERGY STORAGE
Inductive storage-prospects for high power generation, 5:25056
PUMPED STORAGE POWER PLANTS/ENVIRONMENTAL IMPACTS
Pumped storage development and its environmental effects. Final report Dec 1971-May 1974, 5:23794 (PB—299691)
PUMPED STORAGE POWER PLANTS/FEASIBILITY STUDIES
Pumped storage development and its environmental effects. Final report Dec 1971-May 1974, 5:23794 (PB—299691)
PUMPED STORAGE POWER PLANTS/WATER RESOURCES
Pumped storage development and its environmental effects. Final report Dec 1971-May 1974, 5:23794 (PB—299691)
PUMPS
See also VACUUM PUMPS
PUMPS/SHOCK ABSORBERS
Shock absorber for oil well pumping unit (Patent), 5:23584
PVC
(Polyvinyl chloride.)
PVC/AEROSOLS
Physiological and toxicological aspects of degradation products produced during the combustion of polyvinyl chloride polymers, 5:24451 (EPRI-EL—1263)
Smoke and corrosivity, 5:24452 (EPRI-EL—1263)
PVC/PYROLYSIS
Physiological and toxicological aspects of degradation products produced during the combustion of polyvinyl chloride polymers, 5:24451 (EPRI-EL—1263)
Smoke and corrosivity, 5:24452 (EPRI-EL—1263)
PVC/THERMAL DEGRADATION
Smoke and corrosivity, 5:24452 (EPRI-EL—1263)
PVP
(Polyvinylpyrrolidone.)
PVP/CHEMICAL PREPARATION
Heat and chemically resistant membranes, 5:24166
PWR TYPE REACTORS
See also INDIAN POINT-2 REACTOR
LOFT REACTOR
THREE MILE ISLAND-2 REACTOR
PWR TYPE REACTORS/AFTER-HEAT
Fission product decay heat for thermal reactors, 5:24084 (CONF-791058—71)
PWR TYPE REACTORS/DESIGN
Technical report on LWR design decision methodology. Phase I, 5:24044 (SAND—80-0670)
PWR TYPE REACTORS/ECCS
Unique rod lens/video system designed to observe flow conditions in emergency core coolant loops of pressurized water reactors, 5:24048 (UCRL—52902)
PWR TYPE REACTORS/FLOWMETERS
Development of impedance sensors at ORNL: for measurement of two-phase flows, 5:24085 (CONF-791118—10)
PWR TYPE REACTORS/LOSS OF COOLANT
Best-estimate LOCA radiation signature for equipment qualification, 5:24097 (SAND—80-0888C)
Modeling a nuclear reactor for experimental purposes, 5:24087 (CONF-800536—1)
PWR TYPE REACTORS/MELTDOWN
Assessment of molten debris freezing in a severe RIA in-pile test, 5:24088 (CONF-800607—15)
Modeling decay heat-induced melting of a concrete slab by use of the general heat conduction code HEATING 5, 5:24095 (ORNL/TM—7211)
PWR TYPE REACTORS/REACTOR INSTRUMENTATION
Acoustic monitoring of relief valve position, 5:24043 (EPRI-NP—1313)
PWR TYPE REACTORS/REACTOR SAFETY
Methodology for the selection of LWR safety R & D projects. Phase I, status report, 5:24082 (ALO—66)
PWR TYPE REACTORS/RELIEF VALVES
Acoustic monitoring of relief valve position, 5:24043 (EPRI-NP—1313)
PWR TYPE REACTORS/ROD EJECTION ACCIDENTS
Assessment of molten debris freezing in a severe RIA in-pile test, 5:24088 (CONF-800607—15)
PWR TYPE REACTORS/STEAM GENERATORS
PWR steam generator chemical cleaning. Phase II. Final report, 5:24046 (COO—4325-02)
PWR TYPE REACTORS/VALVES
Pilot program to identify valve failures which impact the safety and operation of light water nuclear power plants, 5:24042 (ALO—75)
PYRAZINES/FLUORESCENCE
Photophysics of organic molecules at high pressure, 5:24499 (DOE/ER/01198—1305)
PYRENE/FLUORESCENCE
Evidence for a change in the fluidity of erythrocyte membranes following x irradiation by measurement of pyrene excimer fluorescence, 5:24738
PYRIMIDINES/RADIOLYSIS
Favism inducing agents: a pulse radiolysis study of isouramil and convicine, 5:24735 (DOE/EV/03221—63)
PYROTECHNIC DEVICES
Design and evaluation of progressively burning pyrotechnic formulations, 5:24583 (SAND—80-0355C)
PYROTECHNIC DEVICES/IGNITION
Power independent ignition energy measurements, 5:24581 (MLM—2709(OP))
Role of surface chemistry in the ignition of pyrotechnic materials, 5:24580 (MLM—2708(OP))
Thermal and electrostatic initiation of TiH/sub x/ based pyrotechnics, 5:24582 (MLM—2710(OP))

Q

QUALITY ASSURANCE/DATA PROCESSING
Users manual data base MATSURV. Reactor pressure vessel material surveillance data management system, 5:24072 (ALO—63)
QUANTUM CHROMODYNAMICS/BAG MODEL
Simple model of the ground state of quantum chromodynamics, 5:24880
QUANTUM CHROMODYNAMICS/BOUND STATE
Heavy quarks and new particles, 5:24868
QUANTUM CHROMODYNAMICS/DEEP INELASTIC SCATTERING
QCD phenomenology of deep-inelastic scattering, 5:24862
QUANTUM CHROMODYNAMICS/FERMIONS
Interaction of massless fermions with instantons, 5:24885
QUANTUM CHROMODYNAMICS/GROUND STATES
Simple model of the ground state of quantum chromodynamics, 5:24880
QUANTUM CHROMODYNAMICS/INSTANTONS
Interaction of massless fermions with instantons, 5:24885
QUANTUM CHROMODYNAMICS/PARTON MODEL
Simple quantum-chromodynamic parametrizations of parton distributions beyond the leading order of asymptotic freedom, 5:24857
QUANTUM CHROMODYNAMICS/SYMMETRY BREAKING
Exotic new quarks and dynamical symmetry breaking, 5:24874
QUARK CONFINEMENT
See BAG MODEL
QUARK MODEL
See also FLAVOR MODEL
Evidence for quarks and gluons, 5:24970 (LA—8310-MS)
QUARK MODEL/SYMMETRY BREAKING
Exotic new quarks and dynamical symmetry breaking, 5:24874
QUARK-ANTIQUARK INTERACTIONS/BOUND STATE
Exotic new quarks and dynamical symmetry breaking, 5:24874
QUEUES
Generation of approximating distributions through the method of stages, 5:25104 (BNL—27513)

R

RACKS (FUEL)
See FUEL RACKS
RADIAL FLOW MHD GENERATORS
See DISK MHD GENERATORS
RADIATION DECONTAMINATION
See DECONTAMINATION
RADIATION DOSES
See also INTEGRAL DOSES
RADIATION DOSES/MATHEMATICAL MODELS
PABLM: a computer program to calculate accumulated radiation doses from radionuclides in the environment, 5:24754 (PNL—3209)
RADIATION DOSES/SPATIAL DISTRIBUTION
Numerical simulation of self-induced rainout using a dynamic convective cloud model, 5:24635 (UCRL—83583)
RADIATION DOSIMETRY
See DOSIMETRY
RADIATION EXPOSURE (DOSES)
See RADIATION DOSES
RADIATION HYGIENE
See RADIATION PROTECTION
RADIATION PROTECTION/CURRICULUM GUIDES
Proposed training program for construction personnel involved in remedial action work at sites contaminated by naturally occurring radionuclides, 5:23756 (CONF-791203—9)
RADIATION PROTECTION/PERSONNEL
Proposed training program for construction personnel involved in remedial action work at sites contaminated by naturally occurring radionuclides, 5:23756 (CONF-791203—9)
RADIATION SAFETY
See RADIATION PROTECTION
RADIATIONS/FLUCTUATIONS
Quantum-mechanical fluctuations of the resonance-radiation force, 5:24883
RADIATIVE DECAY/C INVARIANCE
New upper limit for the C-noninvariant decay $\pi^0 \rightarrow 3\gamma$, 5:24843
RADICALS
See also CARBONYL RADICALS
HYDROXYL RADICALS
SUPEROXIDE RADICALS
RADICALS/BIOCHEMICAL REACTION KINETICS
Ligated chlorophyll cation radicals: their function in photosystem II of plant photosynthesis, 5:24680
RADICALS/RADIOINDUCTION
Contribution of endogenous and exogenous damage to the total radiation-induced damage in the bacterial spore, 5:24744 (DOE/EV/03221—64)
RADICALS/RADIOSENSITIVITY EFFECTS
Contribution of endogenous and exogenous damage to the total radiation-induced damage in the bacterial spore, 5:24744 (DOE/EV/03221—64)
RADIO EQUIPMENT POWER SUPPLIES/PRIMARY BATTERIES
Applications of the lithium/carbon mono-fluoride battery, 5:24144
Field tests with lithium/SO_2 batteries, 5:24140
RADIOACTIVE AEROSOLS/ENVIRONMENTAL TRANSPORT
User's manual for DWNWND: an interactive Gaussian plume atmospheric transport model with eight dispersion parameter options, 5:24633 (ORNL/TM—6874)
RADIOACTIVE AEROSOLS/WASHOUT
Numerical simulation of self-induced rainout using a dynamic convective cloud model, 5:24635 (UCRL—83583)
RADIOACTIVE BIOLOGICAL WASTES
See RADIOACTIVE WASTES
RADIOACTIVE PARTICULATES
See PARTICLES
RADIOACTIVE WASTE DISPOSAL
Reduction in the toxicity of fission product wastes through transmutation with deuterium-tritium fusion neutrons, 5:25071
RADIOACTIVE WASTE DISPOSAL/AUTORADIOLYSIS
Gas generation by self-radiolysis of tritiated waste materials, 5:23753
RADIOACTIVE WASTE DISPOSAL/ENVIRONMENTAL IMPACTS
Environmental sampling program for a solar evaporation pond for liquid radioactive wastes, 5:23729 (LA—8177)
RADIOACTIVE WASTE DISPOSAL/GEOCHEMICAL SURVEYS
Review of geochemical measurement techniques for a nuclear waste repository in bedded salt, 5:23748 (UCID—18664)
RADIOACTIVE WASTE DISPOSAL/NEVADA TEST SITE
Prediction of ground motion from underground nuclear weapons tests as it relates to siting of a nuclear waste storage facility at NTS and compatibility with the weapons test program, 5:23745 (SAND—80-1020/1)
Prediction of ground motion from underground nuclear weapons tests as it relates to siting of a nuclear waste storage facility at NTS and compatibility with the weapons test program, 5:23746 (SAND—80-1020/1)
RADIOACTIVE WASTE DISPOSAL/PONDS
Environmental sampling program for a solar evaporation pond for liquid radioactive wastes, 5:23729 (LA—8177)
RADIOACTIVE WASTE DISPOSAL/RADIATION PROTECTION
National Waste Terminal Storage repository in a bedded salt formation for spent unreprocessed fuel. Occupational exposure and health physics studies. KE report No. 78-21-R, 5:23734 (ORO—5366-T2)
RADIOACTIVE WASTE DISPOSAL/RISK ASSESSMENT
Waste Isolation Safety Assessment Program. Technical progress report for FY-1978, 5:23737 (PNL—2874)
RADIOACTIVE WASTE FACILITIES/CLOSURES
Role of borehole plugging in the evaluation of the Waste Isolation Pilot Plant, 5:23744 (SAND—80-0502C)
RADIOACTIVE WASTE FACILITIES/DESIGN
Remarks on the assessment, representation, aggregation and utilization of expert opinion, 5:23749 (UCID—18665)
RADIOACTIVE WASTE FACILITIES/EVALUATION
Identification of technical problems encountered in the shallow land burial of low-level radioactive wastes, 5:23733 (ORNL/SUB—80/13619/1)
RADIOACTIVE WASTE FACILITIES/MONITORING
Monitoring system specifications: retrieval of surf from a salt repository, 5:23752 (UCRL—15232)
RADIOACTIVE WASTE FACILITIES/RADIATION PROTECTION
National Waste Terminal Storage repository in a bedded salt formation for spent unreprocessed fuel. Occupational exposure and health physics studies. KE report No. 78-21-R, 5:23734 (ORO—5366-T2)
RADIOACTIVE WASTE FACILITIES/RADIONUCLIDE MIGRATION
Application of FRAMIS to K/sub D/ data, 5:23747 (UCID—18651)
RADIOACTIVE WASTE FACILITIES/SEISMOLOGY
Basic data report for Drillhole WIPP 22 (Waste Isolation Pilot Plant, WIPP), 5:23741 (SAND—79-0278)
RADIOACTIVE WASTE FACILITIES/SITE SELECTION
Prediction of ground motion from underground nuclear weapons tests as it relates to siting of a nuclear waste storage facility at NTS and compatibility with the weapons test program, 5:23745 (SAND—80-1020/1)
Prediction of ground motion from underground nuclear weapons tests as it relates to siting of a nuclear waste storage facility at NTS and compatibility with the weapons test program, 5:23746 (SAND—80-1020/1)
RADIOACTIVE WASTE MANAGEMENT
See also RADIOACTIVE WASTE STORAGE
RADIOACTIVE WASTE MANAGEMENT/DECISION MAKING
Assessment of effectiveness of geologic isolation systems: the feasibility of computer interrogation of experts for WISAP, 5:23736 (PNL—2862)
RADIOACTIVE WASTE MANAGEMENT/HIGH-LEVEL RADIOACTIVE WASTES
Transuranic contaminated waste functional definition and implementation, 5:23751 (UCRL—15229)
RADIOACTIVE WASTE MANAGEMENT/LOW-LEVEL RADIOACTIVE WASTES
Identification of technical problems encountered in the shallow land burial of low-level radioactive wastes, 5:23733 (ORNL/SUB—80/13619/1)
RADIOACTIVE WASTE MANAGEMENT/PLANNING
Nuclear fuel services waste characterization and waste removal system, 5:23714 (RHO-CD—883)
RADIOACTIVE WASTE MANAGEMENT/RETRIEVAL SYSTEMS
Conceptual design of retrieval systems for emplaced transuranic waste containers in a salt bed depository. Final report, 5:23750 (UCRL—15228)
RADIOACTIVE WASTE MANAGEMENT/SPENT FUELS
Spent fuel storage. Facts booklet, 5:23728 (DOE/NE—0005)
RADIOACTIVE WASTE MANAGEMENT/TRANSURANIUM ELEMENTS
Transuranic contaminated waste functional definition and implementation, 5:23751 (UCRL—15229)
RADIOACTIVE WASTE PROCESSING/GASEOUS WASTES
Removal of tritium and tritium-containing compounds from a gaseous stream (Patent), 5:23764
RADIOACTIVE WASTE PROCESSING/RESIDUES
Plutonium recovery at the Los Alamos Scientific Laboratory, 5:23720 (LA-UR—80-1168)

RADIOACTIVE WASTE PROCESSING/SEPARATION PROCESSES
Methods for separating actinides from reprocessing and refabrication plant wastes, 5:23715 (CONF-791112—63)
RADIOACTIVE WASTE PROCESSING/SOLIDIFICATION
High level nuclear waste, 5:23717 (DP-MS—80-39)
High-level waste program progress report, January 1, 1980-March 31, 1980, 5:23722 (ORNL/TM—7371)
RADIOACTIVE WASTE PROCESSING/TRITIUM
Performance and improvements of the tritium handling facility at the Los Alamos Scientific Laboratory, 5:23721 (LA-UR—80-1265)
RADIOACTIVE WASTE PROCESSING/VITRIFICATION
Modeling principles applied to the simulation of a joule-heated glass melter, 5:23716 (DP—1540)
RADIOACTIVE WASTE STORAGE/ENVIRONMENTAL IMPACTS
Final environmental impact statement: US Spent Fuel Policy. Executive summary, 5:23723 (DOE/EIS—0015(Vol.1))
RADIOACTIVE WASTE STORAGE/GOVERNMENT POLICIES
Final environmental impact statement: US Spent Fuel Policy. Executive summary, 5:23723 (DOE/EIS—0015(Vol.1))
RADIOACTIVE WASTES
See also HIGH-LEVEL RADIOACTIVE WASTES
LOW-LEVEL RADIOACTIVE WASTES
RADIOACTIVE WASTES/LEACHING
Materials Characterization Center workshop on leaching of radioactive waste forms. Summary report, 5:23738 (PNL—3318)
RADIOACTIVITY LOGGING/RESEARCH PROGRAMS
NDA technology for uranium resource evaluation. Progress report, January 1-June 30, 1979, 5:23696 (LA—8321-PR)
RADIOASTRONOMY/IMAGE PROCESSING
Overview of image reconstruction, 5:25105 (BNL—27665)
RADIOCARBON DATING
See CARBON 14
RADIOGRAPHS
See IMAGES
RADIOISOTOPE KINETICS
See RADIONUCLIDE KINETICS
RADIOISOTOPE MIGRATION
See RADIONUCLIDE MIGRATION
RADIOISOTOPES
See also NEUTRON-DEFICIENT ISOTOPES
NEUTRON-RICH ISOTOPES
RADIOISOTOPES/BODY BURDEN
PABLM: a computer program to calculate accumulated radiation doses from radionuclides in the environment, 5:24754 (PNL—3209)
RADIOISOTOPES/DECAY
ENSDF: its structure, contents, and use in applied research, 5:24886 (CONF-791243—1)
RADIOISOTOPES/RADIONUCLIDE MIGRATION
BIODOSE: a code for predicting the dose to man from radionuclides released from underground nuclear waste repositories, 5:24654 (UCID—18652)
RADIOLOGY/IMAGE PROCESSING
Overview of image reconstruction, 5:25105 (BNL—27665)
RADIONUCLIDE KINETICS
(In living organisms.)
RADIONUCLIDE KINETICS/AGE DEPENDENCE
Metabolism of americium-241 in man: an unusual case of internal contamination of a child and his father, 5:24752 (COO—3382-18)
RADIONUCLIDE KINETICS/COMPARATIVE EVALUATIONS
Metabolism of americium-241 in man: an unusual case of internal contamination of a child and his father, 5:24752 (COO—3382-18)
RADIONUCLIDE KINETICS/MATHEMATICAL MODELS
Improved mathematical model for uranium metabolism, 5:24753 (COO—3382-18)
RADIONUCLIDE KINETICS/TIME DEPENDENCE
Curium-243,4 in the tissues of the adult baboon (Time-dependent effects of DTPA administration on excretion), 5:24757 (COO—3382-18)
RADIONUCLIDE MIGRATION
(In environment.)
RADIONUCLIDE MIGRATION/COMPUTERIZED SIMULATION
BIODOSE: a code for predicting the dose to man from radionuclides released from underground nuclear waste repositories, 5:24654 (UCID—18652)
RADIONUCLIDE MIGRATION/MATHEMATICAL MODELS
Thermal gradient brine inclusion migration in salt study: gas-liquid inclusions, preliminary model, 5:23732 (ONWI—85)
User's manual for DWNWND: an interactive Gaussian plume atmospheric transport model with eight dispersion parameter options, 5:24633 (ORNL/TM—6874)
RADIONUCLIDES
See RADIOISOTOPES
RADIOSENSITIVITY EFFECTS/AGE DEPENDENCE
Oxygen effect and adaptive reactions of cells. Report 2. Kinetics of respiration of tumor cells differing in initial respiration level (γ rays; Ehrlich ascites tumor cells), 5:24747
RADIUM/DELAYED RADIATION EFFECTS
Long-term effects of radium exposure in female dial workers: liver function and liver disease, 5:24778
RADIUM 230/BETA-MINUS DECAY
Levels of ^{230}Ac and ^{230}Th populated by decay of ^{230}Ra and ^{230}Ac, 5:24935
RADON 199/ALPHA DECAY
New isotope ^{199}Rn and evidence for an isomeric state ^{199}Rn/sup m/, 5:24929
RADON 220/DAUGHTER PRODUCTS
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)
RADON 220/ENVIRONMENTAL TRANSPORT
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)
RADON 222/DAUGHTER PRODUCTS
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)
RADON 222/ENVIRONMENTAL TRANSPORT
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)
RADON 222/MONITORING
Ceramic BeO exoelectron dosimeters for tritium and radon monitoring, 5:24561 (CONF-7910149—1)
RADON 222/RADIATION MONITORING
Determination of ^{226}Ra, ^{214}Pb, and ^{214}Bi in fly ash samples from eighteen (18) coal fired power plants in the United States, 5:23457 (METC/SP—79/10(Pt.1))
RAFT RIVER VALLEY/GEOTHERMAL WELLS
Geophysical logging case history of the Raft River geothermal system, Idaho, 5:23987 (LA—8252-MS)
RAIL TRANSPORT/ENERGY CONSUMPTION
Energy study of railroad freight transportation. Volume 3. Regulation and tariff, 5:24269 (SAN—1176-T1(Vol.3))
RAIL TRANSPORT/FINANCIAL DATA
Energy study of railroad freight transportation. Volume 1. Executive summary, 5:24267 (SAN—1176-T1(Vol.1))
Energy study of railroad freight transportation. Volume 2. Industry description, 5:24268 (SAN—1176-T1(Vol.2))
Energy study of railroad freight transportation. Volume 3. Regulation and tariff, 5:24269 (SAN—1176-T1(Vol.3))
Energy study of railroad freight transportation. Volume 4. Efficiency improvements and industry future, 5:24270 (SAN—1176-T1(Vol.4))
RAILROAD CARS/OWNERSHIP
Energy study of railroad freight transportation. Volume 3. Regulation and tariff, 5:24269 (SAN—1176-T1(Vol.3))
RAILWAYS
See also ELECTRIC RAILWAYS
RAILWAYS/COMPARATIVE EVALUATIONS
Economic considerations of rail and pipeline transportation of coal, 5:23549
RAILWAYS/ENERGY CONSERVATION
Energy study of railroad freight transportation. Volume 2. Industry description, 5:24268 (SAN—1176-T1(Vol.2))
Energy study of railroad freight transportation. Volume 4. Efficiency improvements and industry future, 5:24270 (SAN—1176-T1(Vol.4))
RAILWAYS/ENERGY EFFICIENCY
Circuity and the energy-intnsiveness of inland waterway and rail freight transport systems: a progress report (Including circuity), 5:23553
RAILWAYS/FUEL CONSUMPTION
Characteristics of urban transportation systems: a handbook for transportation planners. Final report, 5:24283 (PB—301319)
Energy study of railroad freight transportation. Volume 1. Executive summary, 5:24267 (SAN—1176-T1(Vol.1))
Energy study of railroad freight transportation. Volume 2. Industry description, 5:24268 (SAN—1176-T1(Vol.2))
Energy study of railroad freight transportation. Volume 3. Regulation and tariff, 5:24269 (SAN—1176-T1(Vol.3))
RAILWAYS/REGULATIONS
Energy study of railroad freight transportation. Volume 3. Regulation and tariff, 5:24269 (SAN—1176-T1(Vol.3))
RAILWAYS/SECURITY
Security problems in the rail transportation of coal, 5:23556

RANKINE CYCLE POWER SYSTEMS/COMPUTERIZED SIMULATION
Dynamic and off-design analysis of OTEC closed cycle power systems, 5:23863 (CONF-790631—(Vol.1))
RANKINE CYCLE POWER SYSTEMS/DESIGN
Dynamic and off-design analysis of OTEC closed cycle power systems, 5:23863 (CONF-790631—(Vol.1))
RAPID TRANSIT SYSTEMS
See also ELECTRIC RAILWAYS
RAPID TRANSIT SYSTEMS/ECONOMIC ANALYSIS
Energy study of automated guideway transit (AGT) systems, 5:24271 (SAN—1176-T3)
RAPID TRANSIT SYSTEMS/ENERGY CONSUMPTION
Energy study of automated guideway transit (AGT) systems, 5:24271 (SAN—1176-T3)
RAPID TRANSIT SYSTEMS/FLYWHEEL ENERGY STORAGE
Energy storage propulsion system for rapid transit cars. Test results and system evaluation. Final report, 5:24347 (PB—300918)
RAPID TRANSIT SYSTEMS/FUEL CONSUMPTION
Characteristics of urban transportation systems: a handbook for transportation planners. Final report, 5:24283 (PB—301319)
RAPID TRANSIT SYSTEMS/PERFORMANCE TESTING
SLRV (standard light rail vehicle) engineering tests at department of transportation, transportation test center. Final test report. Volume II. Performance and power consumption tests. Final report January-June 1976, 5:24266 (PB—301147)
RAPID TRANSIT SYSTEMS/POWER DEMAND
SLRV (standard light rail vehicle) engineering tests at department of transportation, transportation test center. Final test report. Volume II. Performance and power consumption tests. Final report January-June 1976, 5:24266 (PB—301147)
RARE EARTH COMPOUNDS/CORROSION RESISTANCE
Improved structural silicon nitride materials containing rare earth oxides (Patent), 5:24433
RARE EARTH COMPOUNDS/FABRICATION
Improved structural silicon nitride materials containing rare earth oxides (Patent), 5:24433
RARE EARTH COMPOUNDS/PHASE DIAGRAMS
Improved structural silicon nitride materials containing rare earth oxides (Patent), 5:24433
RARE EARTH NUCLEI/COLLECTIVE MODEL
Flow patterns for collective rotations in heavy nuclei, 5:24920
RARE EARTH NUCLEI/YRAST STATES
Is there evidence for rotation along the axis of symmetry in transitional nuclei, 5:24919
RARE EARTHS
See also CERIUM
DYSPROSIUM
ERBIUM
EUROPIUM
GADOLINIUM
HOLMIUM
LANTHANUM
LUTETIUM
SAMARIUM
YTTERBIUM
RARE EARTHS/CATALYTIC EFFECTS
Catalyst for synthesis of methanol (Patent), 5:23774
REACTION INTERMEDIATES/BIOCHEMICAL REACTION KINETICS
Favism inducing agents: a pulse radiolysis study of isouramil and convicine, 5:24735 (DOE/EV/03221—63)
REACTOR COMPONENTS
See also BREEDING BLANKETS
FUEL ELEMENTS
REACTOR COMPONENTS/CLEANING
Evaporative removal of sodium from reactor components, 5:24064
REACTOR COMPONENTS/ELASTICITY
Accurate numerical solutions for elastic-plastic models (LMFBR), 5:24052 (ANL—80-31)
REACTOR COMPONENTS/PLASTICITY
Accurate numerical solutions for elastic-plastic models (LMFBR), 5:24052 (ANL—80-31)
REACTOR CONTROL THEORY
See REACTOR KINETICS
REACTOR CORE DISRUPTION/FLASHING
Nonequilibrium phenomena in flashing water used as an HCDA source simulant. Technical report No. 8 (LMFBR), 5:24096 (SAN—0115-T7)
REACTOR CORE DISRUPTION/HEAT TRANSFER
Chemical simulation modeling of heat transfer in LMFBRs, 5:24091 (DOE/ET/37205—T1)
Improvement and verification of fast reactor safety analysis techniques. Progress report, October 1, 1979-March 31, 1980 (LMFBR), 5:24089 (COO—2571-19)
REACTOR CORE DISRUPTION/HYDRAULICS
Chemical simulation modeling of heat transfer in LMFBRs, 5:24091 (DOE/ET/37205—T1)
Improvement and verification of fast reactor safety analysis techniques. Progress report, October 1, 1979-March 31, 1980 (LMFBR), 5:24089 (COO—2571-19)
Nonequilibrium phenomena in flashing water used as an HCDA source simulant. Technical report No. 8 (LMFBR), 5:24096 (SAN—0115-T7)
REACTOR CORE DISRUPTION/RADIOACTIVE AEROSOLS
ORNL experiments to characterize fuel release from the reactor primary containment in severe LMFBR accidents, 5:24086 (CONF-800434—2)
REACTOR FUEL ELEMENTS
See FUEL ELEMENTS
REACTOR FUELING/CLOSURES
Self locking drive system for rotating plug of a nuclear reactor (Patent), 5:24065
REACTOR INSTRUMENTATION/ACOUSTIC MONITORING
Acoustic monitoring of relief valve position (PWR; BWR), 5:24043 (EPRI-NP—1313)
REACTOR KINETICS
Solving the nuclear reactor core problems, 5:24071 (CONF-791186—1)
REACTOR KINETICS/CROSS SECTIONS
Covariances of fission-integral measurements at the NBS ^{252}Cf and ISNF facilities and at the ORNL-PCA facility, 5:24070 (CONF-791051—23)
REACTOR MATERIALS
(See also specific materials.)
REACTOR MATERIALS/CREEP
Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, October 1, 1979-December 31, 1979, 5:24049 (COO—2975-40)
REACTOR MATERIALS/PHYSICAL RADIATION EFFECTS
Experimental observations of effects of inert gas on cavity formation during irradiation, 5:24423 (ORNL/TM—7193)
Relating surveillance capsule measurements to pressure vessel damage, 5:24073 (BNL-NUREG—27192)
REACTOR MATERIALS/QUALITY ASSURANCE
Users manual data base MATSURV. Reactor pressure vessel material surveillance data management system, 5:24072 (ALO—63)
REACTOR MATERIALS/STANDARDS
Nuclear standards transmittal, 5:24067 (RDT-M—3-34T(4-80)(Rev.))
Nuclear standards transmittal, 5:24068 (RDT-M—3-4T(4-80)(Rev.))
REACTOR MATERIALS/TENSILE PROPERTIES
Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, October 1, 1979-December 31, 1979, 5:24049 (COO—2975-40)
REACTOR MATERIALS/THERMAL CONDUCTIVITY
Thermal conductivities of mixed carbide fuel and blanket materials (LMFBR), 5:24058 (LA-UR—80-1283)
REACTOR MATERIALS/THERMAL DIFFUSIVITY
Thermal conductivities of mixed carbide fuel and blanket materials (LMFBR), 5:24058 (LA-UR—80-1283)
REACTOR SAFETY
(Theoretical and experimental investigations of the behavior of reactor types and designs under various real or hypothetical accidents.)
REACTOR SAFETY/RESEARCH PROGRAMS
Metholology for the selection of LWR safety R & D projects. Phase I, status report, 5:24082 (ALO—66)
REACTORS
See also POWER REACTORS
WATER COOLED REACTORS
REACTORS/PRESSURE VESSELS
Use of acoustic emission for assessing the integrity of a nuclear reactor pressure vessel, 5:24392
RECORDING SYSTEMS/DIGITAL CIRCUITS
Microprocessor-controlled time domain reflectometer for dynamic shock position measurements, 5:24586
RECREATIONAL AREAS
Modelling the demand for long-distance day trips to the lake district, 5:24289 (PB—300617)
RECTENNAS/LAND REQUIREMENTS
Preliminary comparative assessment of land use for the satellite power system (SPS) and alternative electric energy technologies, 5:23848 (DOE/ER—0054)
RECYCLE (FUEL)
See FUEL CYCLE
RECYCLING (FUEL)
See REPROCESSING
REFRACTORIES/CHEMICAL COMPOSITION
Materials technology for coal-conversion processes. Nineteenth report, July-December 1979, 5:23417 (ANL—80-12)

REFRACTORIES/MATERIALS TESTING
Materials technology for coal-conversion processes. Nineteenth report, July-December 1979, 5:23417 (ANL—80-12)
REFRACTORY METALS/BONDING
Chemical vapor deposition of sialon (Patent), 5:24425
Silicon-nitride and metal composite (Patent), 5:24427
REFRACTORY METALS/CORROSION RESISTANCE
Silicon-nitride and metal composite (Patent), 5:24427
REFUSE
See SOLID WASTES
REGRESSION ANALYSIS
Sample size for logistic regression with small response probability. Technical report No. 33, 5:25108 (DOE/EV/02874—64)
REINDEER
See DEER
RELIEF VALVES/ACOUSTIC MONITORING
Acoustic monitoring of relief valve position (PWR; BWR), 5:24043 (EPRI-NP—1313)
REM
See DOSE EQUIVALENTS
REMOTE AREAS/POWER SYSTEMS
Recent terrestrial and undersea applications of radioisotope thermoelectric generators, 5:23767
REMOTE VIEWING EQUIPMENT/PERFORMANCE
Unique rod lens/video system designed to observe flow conditions in emergency core coolant loops of pressurized water reactors, 5:24048 (UCRL—52902)
REMOTE VIEWING EQUIPMENT/SPECIFICATIONS
Unique rod lens/video system designed to observe flow conditions in emergency core coolant loops of pressurized water reactors, 5:24048 (UCRL—52902)
RENE-100/CREEP
Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, October 1, 1979-December 31, 1979, 5:24049 (COO—2975-40)
RENE-100/TENSILE PROPERTIES
Advanced gas cooled nuclear reactor materials evaluation and development program. Progress report, October 1, 1979-December 31, 1979, 5:24049 (COO—2975-40)
REPROCESSING/RADIATION HAZARDS
Reprocessing nuclear fuels of the future: a radiological assessment of advanced (Th,U) carbide fuel, 5:23704
REPRODUCTION/BIOLOGICAL INDICATORS
Plant developmental system to measure the impact of pollutants in rain water, 5:24768
REPRODUCTION/PATHOLOGICAL CHANGES
Plant developmental system to measure the impact of pollutants in rain water, 5:24768
RESEARCH PROGRAMS/BIBLIOGRAPHIES
Bibliography of the Interagency Energy/Environment R and D Program, 5:24593 (EPA—600/9-79-015)
RESEARCH PROGRAMS/PLANNING
Methodology for the selection of LWR safety R & D projects. Phase I, status report, 5:24082 (ALO—66)
RESEARCH REACTORS
See also FFTF REACTOR
RESEARCH REACTORS/PIPES
Nuclear standards transmittal, 5:24067 (RDT-M—3-34T(4-80)(Rev.))
RESEARCH REACTORS/TUBES
Nuclear standards transmittal, 5:24067 (RDT-M—3-34T(4-80)(Rev.))
Nuclear standards transmittal, 5:24068 (RDT-M—3-4T(4-80)(Rev.))
RESERVOIRS (WATER)
See WATER RESERVOIRS
RESIDENTIAL BUILDINGS
See also APARTMENT BUILDINGS
HOUSES
RESIDENTIAL BUILDINGS/ANNUAL CYCLE ENERGY SYSTEM
Economic evaluation of the Annual Cycle Energy System (ACES). Volume II. Detailed results. Final report, 5:24246 (ORNL/Sub—7470/1-V2)
RESIDENTIAL BUILDINGS/ENERGY BUDGETS
Examination of implementation strategies for the Building Energy Performance Standards, 5:24255 (DOE/PE/70106—T1)
RESIDENTIAL BUILDINGS/ENERGY CONSERVATION
Residential energy conservation. Volume II. Working papers, 5:24257 (PB—301200)
Residential Energy Consumption Survey: conservation, 5:24254 (DOE/EIA—0207/3)
RESIDENTIAL BUILDINGS/ENERGY CONSUMPTION
Buildings energy use data book. Edition 2, 5.24244 (ORNL—5552)
Examination of implementation strategies for the Building Energy Performance Standards, 5:24255 (DOE/PE/70106—T1)
RESIDENTIAL BUILDINGS/FUEL CONSUMPTION
Residential energy consumption survey: characteristics of the housing stock and households, 5:24253 (DOE/EIA—0207/2)
RESIDENTIAL BUILDINGS/FURNACES
High efficiency furnace with low pollution emissions (Patent), 5:24259
RESIDENTIAL BUILDINGS/GEOTHERMAL SPACE HEATING
Geothermal Energy Market Study on the Atlantic Coastal Plain. Geothermal Energy Market penetration: development of a model for the residential sector, 5:23998 (DOE/ET/27025—T1)
RESIDENTIAL BUILDINGS/HEAT STORAGE
Thermal Energy Storage Test Facility, 5:24249 (CONF-791242—2)
RESIDENTIAL BUILDINGS/HEATING SYSTEMS
K and D activities in pulse combustion at BNL, 5:24248 (BNL—27602)
RESIDENTIAL BUILDINGS/PASSIVE SOLAR HEATING SYSTEMS
Residential passive solar energy design competition for North Carolina. Final report, November 1, 1978-April 9, 1979, 5:23889 (NCEI—0013)
RESIDENTIAL BUILDINGS/SOLAR HEATING SYSTEMS
Residential solar home resale analysis, 5:23885 (LA-UR—80-1014)
RESIDENTIAL BUILDINGS/SOLAR SPACE HEATING
Electric utilities and residential solar systems, 5:23877 (BNL—27711)
RESIDENTIAL BUILDINGS/SOLAR WATER HEATING
Electric utilities and residential solar systems, 5:23877 (BNL—27711)
RESIDENTIAL SECTOR/ENERGY CONSUMPTION
International comparisons of the residential demand for energy, 5:24258
RESIDENTIAL SECTOR/ENERGY DEMAND
International comparisons of the residential demand for energy, 5:24258
RESIDENTIAL SECTOR/SPACE HEATING
Community planning for home-heating emergencies: a guide for Community-Action Agencies and other community-based organizations (Booklet), 5:24251 (CSA-PAMPHLET—6143-15)
RESIDUAL OILS
See PETROLEUM RESIDUES
RESIDUES
See also ASHES
RESIDUES/WASTE DISPOSAL
Environmentally acceptable disposal of coal conversion solid waste residuals. Progress report, April 21, 1979-July 31, 1979, 5:23458 (DOE/PC/20023—1)
RESIDUES (RADIOACTIVE)
See RADIOACTIVE WASTES
RESONANCE
See also GIANT RESONANCE
RESONANCE/FLUCTUATIONS
Quantum-mechanical fluctuations of the resonance-radiation force, 5:24883
RESOURCE RECOVERY ACTS
Impact of proposed RCRA regulations on resource recovery and utilization, 5:23463 (METC/SP—79/10(Pt.1))
RESOURCE RECOVERY FACILITIES/ECONOMIC ANALYSIS
A pollution-free system for the economic utilization of municipal solid waste, task 10, electrochemical recovery of non ferrous metals derived from municipal refuse, 5:24326 (PB—299753)
RESPONSE MODIFYING FACTORS/AGE DEPENDENCE
Pituitary-adrenal response in neonatal rats, 5:24716
RESTAURANTS/SOLAR WATER HEATING
Solar energy system performance evaluation, Hogate's Restaurant, Washington, DC, June-August, 1978, 5:23941 (SOLAR/2028—78/14)
RETAIL PRICES/SUBSIDIES
State of competition in gasoline marketing. The effects of refiner operation at retail (a study required by Title III of the Petroleum Marketing Practices Act), 5:23600 (DOE/PE—0019(Vol.1))
RETORTED SHALES
See SPENT SHALES
RETRIEVAL SYSTEMS/DESIGN
Conceptual design of retrieval systems for emplaced transuranic waste containers in a salt bed depository. Final report, 5:23750 (UCRL—15228)
REVERSE-FIELD PINCH/ADIABATIC PROCESSES
Adiabatic compression of field-reversed plasma, 5:25050 (UCID—18614)
REVERSE-FIELD PINCH/EQUILIBRIUM PLASMA
Energy principle with global invariants, 5:25017 (PPPL—1659)
REVERSE-FIELD PINCH/JOULE HEATING
Ohmic heating of the reversed-field pinch, 5:24979 (LA—8325-MS)
REVERSE-FIELD PINCH/MAGNETOHYDRODYNAMICS
Persistence of magnetohydrodynamic stability in field reversed pinches against microinstability, 5:25028

REVERSE-FIELD PINCH/PLASMA MACROINSTABILITIES
Plasma rotation in reversed-field theta pinches, 5:25025 (MSNW—80-1144-1)
REVERSE-FIELD PINCH/PLASMA MICROINSTABILITIES
Persistence of magnetohydrodynamic stability in field reversed pinches against microinstability, 5:25028
REVERSE-FIELD PINCH/PLASMA SIMULATION
Simulations of the ZT-S reversed field pinch, 5:24985
REVERTANTS/RADIOINDUCTION
Ultraviolet-induced reversion of cyc1 alleles in radiation-sensitive strains of yeast. III. rev 3 mutant strains, 5:24745
RHENIUM/CRYSTAL STRUCTURE
Structure of the clean Re(1010) surface, 5:24379
RHENIUM/SURFACES
Structure of the clean Re(1010) surface, 5:24379
RHENIUM 180/BETA-PLUS DECAY
Decay of ^{180}Re: Search for octupole states in ^{180}W, 5:24921
RHO-765 RESONANCES/PARTICLE WIDTHS
Radiative width of the rho⁻ meson, 5:24841
RHO-765 RESONANCES/RADIATIVE DECAY
Radiative width of the rho⁻ meson, 5:24841
RHODIUM/CATALYTIC EFFECTS
Removal of tritium and tritium-containing compounds from a gaseous stream (Patent), 5:23764
RHODOPSEUDOMONAS/TOLERANCE
Photooxidation of antenna bacteriochlorophyll in chromatophores from carotenoidless mutant Rhodopseudomonas sphaeroides and the attendant loss of dimeric exciton interaction, 5:24682
RIBONUCLEIC ACID
See RNA
RICHLAND FFTF REACTOR
See FFTF REACTOR
RICHLAND NPR REACTOR
See N-REACTOR
RIEMANN WAVES
See SHOCK WAVES
RIFT ZONES/COMPARATIVE EVALUATIONS
Magnetotelluric soundings of crustal conductive zones in major continental rifts, 5:24789
RIGHTS-OF-WAY/MONITORING
Monitoring on rights-of-way and the National Biomonitoring Inventory, 5:24642 (CONF-7910141—1)
RINGS (STORAGE)
See STORAGE RINGS
RIO GRANDE RIFT/ENVIRONMENTAL IMPACTS
Geothermal environmental impact assessment: subsurface environmental assessment for four geothermal systems, 5:23994 (PB—300851)
RIO GRANDE RIFT/MAGNETOTELLURIC SURVEYS
Magnetotelluric soundings of crustal conductive zones in major continental rifts, 5:24789
RIO GRANDE RIFT/RESOURCE DEVELOPMENT
Geothermal environmental impact assessment: subsurface environmental assessment for four geothermal systems, 5:23994 (PB—300851)
RISER CRACKING
See COAL LIQUEFACTION
RISK ASSESSMENT/COMPUTER CODES
Assessment of effectiveness of geologic isolation systems: the feasibility of computer interrogation of experts for WISAP, 5:23736 (PNL—2862)
RISK ASSESSMENT/RADIATION HAZARDS
What is risk assessment, 5:23757 (RHO-SA—165)
RISKS
See HAZARDS
RNA
(Ribonucleic acid.)
See also MESSENGER-RNA
TRANSFER RNA
RNA/BIOSYNTHESIS
Reproductive survival and macromolecular synthesis in cultured mammalian cells exposed to single metabolites and mixtures of metabolites of benzo(a)pyrene, 5:24762 (CONF-791059—6)
RNA/HYBRIDIZATION
Sequence complexity of polyadenylated ribonucleic acid from soybean suspension culture cells, 5:24699
ROADS/BUILDING MATERIALS
Advances in marketing Pozzolanic road bases, 5:23503 (METC/SP—79/10(Pt.2))
Ash utilization in bikeway construction, 5:23496 (METC/SP—79/10(Pt.2))
Design and construction of experimental haul road and parking lot facilities utilizing power plant ash, 5:23495 (METC/SP—79/10(Pt.2))
Engineering approach for using power plant ash in a structural fill, 5:23497 (METC/SP—79/10(Pt.2))
Fly ash/boiler slag road bases, 5:23501 (METC/SP—79/10(Pt.2))
Fly ash in paving and structural concrete, 5:23489 (METC/SP—79/10(Pt.2))
Material characteristics of power plant bottom ashes and their performance in bituminous mixtures: a laboratory investigation, 5:23502 (METC/SP—79/10(Pt.2))
Performance of waste coal ash as highway subbase course, 5:23500 (METC/SP—79/10(Pt.2))
Role of fly ash in structural types of stabilized applications, 5:23478 (METC/SP—79/10(Pt.1))
The application of brown coal fly ash to road base courses. Final report (Poland), 5:24318 (PB—300879)
The use of waste and low-grade materials in road construction. 6. Spent oil shale, 5:23647 (PB—299940)
Utilization of fly ash and coal mine refuse as a road base material. Final report 1973-77, 5:24316 (PB—300761)
ROADS/CONSTRUCTION
Performance of waste coal ash as highway subbase course, 5:23500 (METC/SP—79/10(Pt.2))
ROADS/STABILIZATION
Performance of waste coal ash as highway subbase course, 5:23500 (METC/SP—79/10(Pt.2))
ROADS/TRAFFIC CONTROL
Analyzing the FREQ3CP freeway operations simulation model. Research report, 5:24276 (PB—301117)
ROCK BURSTS/FRACTURE PROPERTIES
Criteria for impulsive rock fracture, 5:24792
ROCK SPRINGS SITES
Post-burn study of the Rock Springs, Site 9 in situ retorting experiment, 5:23630
ROCKWELL INTERNATIONAL PROCESS
See MOLTEN SALT COAL GASIFICATION PROCESS
ROCKY FLATS PLANT/RADIOACTIVITY
Annual environmental monitoring report, January-December 1979, 5:24646 (RFP-ENV—79)
ROD DROP ACCIDENTS/SIMULATION
Assessment of molten debris freezing in a severe RIA in-pile test, 5:24088 (CONF-800607—15)
ROD EJECTION ACCIDENTS/SIMULATION
Assessment of molten debris freezing in a severe RIA in-pile test, 5:24088 (CONF-800607—15)
ROENTGEN EQUIVALENT MAN
See DOSE EQUIVALENTS
ROOFS/FLAT PLATE COLLECTORS
Solar heat roofing system (Patent), 5:23963
ROSENBLUM COUNTERS
See SPARK COUNTERS
ROTORS/POROSITY
Chemical vapor deposition of sialon (Patent), 5:24425
ROTORS/SORPTIVE PROPERTIES
Chemical vapor deposition of sialon (Patent), 5:24425
RUBBER INDUSTRY/MATERIALS RECOVERY
Industrial recovered-materials-utilization targets for the rubber industry. Final report, 5:24319 (SAN—1701-T1)
RUBBER INDUSTRY/WASTE PRODUCT UTILIZATION
Industrial recovered-materials-utilization targets for the rubber industry. Final report, 5:24319 (SAN—1701-T1)
RUBBER (NATURAL)
See NATURAL RUBBER
RUBBERS
See also NATURAL RUBBER
RUBBERS/CONSUMPTION RATES
Industrial recovered-materials-utilization targets for the rubber industry. Final report, 5:24319 (SAN—1701-T1)
RUBIDIUM 85/ENERGY LEVELS
Level properties of $^{85}_{37}Rb_{48}$ from the decay of the ^{85}Kr and ^{85}Sr isomers and the cluster-vibration model, 5:24913
RUBIDIUM IONS/ELECTRON-ION COLLISIONS
Absolute experimental cross sections for the electron impact ionization of rubidium. Technical summary report, 5:24820 (ORO—3027-52)
RUNOFF/MATHEMATICAL MODELS
Effects of contour coal strip mining on stormwater runoff and quality, 5:23518 (ORO—4946-T1)
RUNOFF/SIMULATION
Effects of contour coal strip mining on stormwater runoff and quality, 5:23518 (ORO—4946-T1)
RUPTURE DISKS
See RELIEF VALVES
RURAL AREAS/AIR QUALITY
Air quality data for nonmetallic inorganic ions: NH4+, NO3-, SO4= from the National Air Surveillance Networks, 1976. Final report, 5:24610 (PB—300458)

S

SACCHAROMYCES CEREVISIAE/GENETICS
Mutator affecting the region of the iso-1-cytochrome c gene in yeast, 5:24712
SACCHAROSE/PRESERVATION
Carbohydrate crops as a renewable resource for fuels production. Volume III. Juice preservation, 5:23833 (BMI—2031(Vol.3))
SAFEGUARDS
Implementation of the engineering safeguards program (ESP) into nuclear fuel recycle facilities, 5:23759 (CONF-790707—36)
SAFETY ENGINEERING/MANUALS
Natural gas pipeline safety in residential areas served by master meters. a handbook, 5:23611 (PB—300118)
SAFETY (NUCLEAR)
See RADIATION PROTECTION
SALT DEPOSITS/GEOCHEMISTRY
Review of geochemical measurement techniques for a nuclear waste repository in bedded salt, 5:23748 (UCID—18664)
SALT DEPOSITS/INCLUSIONS
Thermal gradient brine inclusion migration in salt study: gas-liquid inclusions, preliminary model, 5:23732 (ONWI—85)
SAMARIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
SAMARIUM 148 TARGET/OXYGEN 16 REACTIONS
Fusion of $^{16}O+$/sup 148,150,152,154/Sm at sub-barrier energies, 5:24916
SAMARIUM 150 TARGET/OXYGEN 16 REACTIONS
Fusion of $^{16}O+$/sup 148,150,152,154/Sm at sub-barrier energies, 5:24916
SAMARIUM 152 TARGET/OXYGEN 16 REACTIONS
Fusion of $^{16}O+$/sup 148,150,152,154/Sm at sub-barrier energies, 5:24916
SAMARIUM 154 TARGET/OXYGEN 16 REACTIONS
Fusion of $^{16}O+$/sup 148,150,152,154/Sm at sub-barrier energies, 5:24916
SAMPLING/MATHEMATICAL MODELS
Limiting behavior of sampling proportional to random size, 5:23572 (CONF-791241—1)
SAMPLING/SIZE
Sample size for logistic regression with small response probability. Technical report No. 33, 5:25108 (DOE/EV/02874—64)
SANITARY LANDFILLS/ENVIRONMENTAL IMPACTS
Boone County field site interim report. Test cells 2A, 2B, 2C, and 2D. Interim report August 1972-December 1976, 5:24648 (PB—299689)
SATELLITE POWER SYSTEM
See ORBITAL SOLAR POWER PLANTS
SATELLITE SOLAR POWER STATIONS
See ORBITAL SOLAR POWER PLANTS
SATELLITES/NICKEL-CADMIUM BATTERIES
INTELSAT IV Ni-Cd battery orbital performance (21 Ah), 5:24132
Long life lightweight nickel-cadmium battery development (22.5 Wh/kg, 1200 W), 5:24110
Performance of nickel-cadmium satellite cells having new electrochemically impregnated, sintered electrodes (50 Ah (nominal)), 5:24134
SATELLITES/NICKEL-HYDROGEN BATTERIES
Design of long life nickel hydrogen cells, 5:24112
Improvement and cycle testing of Ni/H_2 cells (14 Ah), 5:24135
$LaNi_5$ electrodes in nickel-hydrogen batteries, 5:24164
SATELLITES/SILVER-ZINC BATTERIES
Long-term storage effects on sealed Ag-Zn cells (Approx. 40 Ah), 5:24139
SAVANNAH RIVER PLANT/RADIATION MONITORING
Environmental monitoring in the vicinity of the Savannah River Plant. Annual report for 1979, 5:24629 (DPSPU—80-30-1)
SCANDINAVIA
See also SWEDEN
SCANDINAVIA/SOLAR ENERGY
Solar energy in Europe, 5:23796
SCANDIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
SCANDIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
SCANDIUM/EMISSION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
SCHOOL BUILDINGS/ENERGY CONSERVATION
Energy conservation and management guide for small municipalities and school districts, 5:24261 (PB—300223)
SCHOOL BUILDINGS/ENERGY CONSUMPTION
Buildings energy use data book. Edition 2, 5:24244 (ORNL—5552)
SCHOOL BUILDINGS/SOLAR SPACE HEATING
Longfellow solar demonstration project, 5:23901
Scattergood School solar heating system, 5:23898
SCHOOL BUILDINGS/SOLAR WATER HEATING
Scattergood School solar heating system, 5:23898
SCHOTTKY BARRIER DIODES/DESIGN
Amorphous lead dioxide photovoltaic generator (Patent), 5:23831
SCHOTTKY DEFECTS/STRESS RELAXATION
Elastic relaxation associated with the formation and motion of Schottky defects in ionic crystals, 5:24459
SCINTILLATION COUNTING/CALIBRATION STANDARDS
Critical examination of some newly available standards for liquid scintillation counting, 5:24720
SCRUBBERS/SLUDGES
Disposal of high alkaline fly ash sludge in a decoaled mine seam, 5:23505 (METC/SP—79/10(Pt.2))
SEALS/FABRICATION
Glass-ceramics for lightning arrestor connector seals, 5:24429 (SAND—80-0215)
SEALS/PERFORMANCE
Development of bakeable seals for large noncircular ports on the Tokamak Fusion Test Reactor, 5:24534
SEAWATER/CHEMICAL ANALYSIS
Strategies for marine pollution monitoring, 5:24653
SEAWATER/SAMPLING
Strategies for marine pollution monitoring, 5:24653
SEAWATER/UPWELLING
Consequences of natural upwelling in oligotrophic marine ecosystems, 5:23862 (BNL—27710)
SEAWEEDS/ANAEROBIC DIGESTION
Anaerobic digestion of marine biomass, 5:23840
SEDIMENTS/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
SEDIMENTS/CHEMICAL ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
SEDIMENTS/RADIONUCLIDE MIGRATION
Distribution of $^{239,240}Pu$, ^{238}Pu, and ^{137}Cs in various particle size classes of Lake Michigan sediments, 5:24655
SEDIMENTS/SORPTIVE PROPERTIES
Sorption studies at Hanford for the control of radioactive wastes, 5:23740 (RHO-SA—155)
SEED RECOVERY/MATHEMATICAL MODELS
MHD component and system modeling, 5:24219 (FE—2215-13(Vol.2))
SEEDS/GERMINATION
Phytotoxicity and plant response to aqueous effluents derived from an in situ oil shale process water, 5:23664
SEISMIC DETECTION/COMPARATIVE EVALUATIONS
High frequency seismic signals at five United States observatories. Final report, 5:24784 (UCRL—15220)
SEISMIC DETECTION/SHORT WAVE RADIATION
High frequency seismic signals at five United States observatories. Final report, 5:24784 (UCRL—15220)
SELENIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
SELENIUM/ACTIVATION ANALYSIS
Activation analysis, 5:24485
Instrumental analysis of trace elements in thumbnails of human subjects, 5:24484
SELF-SERVE STATIONS
See GASOLINE SERVICE STATIONS
SEMICONDUCTOR DIODES
See also LIGHT EMITTING DIODES
SEMICONDUCTOR DIODES/CHARGE CARRIERS
Evidence of tunnel-assisted transport in nondegenerate MOS and semiconductor-oxide-semiconductor diodes at room temperature, 5:24539

SEMICONDUCTOR MATERIALS
(See also specific semiconductor materials.)
SEMICONDUCTOR MATERIALS/CHARGE CARRIERS
Hot carrier injection at semiconductor-electrolyte junctions, 5:24542
SEMICONDUCTOR MATERIALS/DEFECTS
Structural defects in laser- and electron-beam annealed silicon, 5:24374 (CONF-791112—62)
SEMICONDUCTOR MATERIALS/ELECTRIC CONTACTS
Formation of Ohmic contacts in semiconducting oxides, 5:24431
SEMICONDUCTOR MATERIALS/FABRICATION
Formation of Ohmic contacts in semiconducting oxides, 5:24431
Numerical methods for the analysis of laser annealing of doped semiconductor wafers, 5:24368 (K/CSD/INF—79/27)
SEMICONDUCTOR MATERIALS/MICROSTRUCTURE
Structural defects in laser- and electron-beam annealed silicon, 5:24374 (CONF-791112—62)
SERPUKHOV SYNCHROTRON/ION BEAM INJECTION
Experiments on high-current proton beams at Novosibirsk, 5:24549 (UCRL-Trans—1592)
SERPUKHOV SYNCHROTRON/PROTON BEAMS
Experiments on high-current proton beams at Novosibirsk, 5:24549 (UCRL-Trans—1592)
SERUM (BLOOD)
See BLOOD SERUM
SERVICE STATIONS
See GASOLINE SERVICE STATIONS
SEWAGE
See LIQUID WASTES
SEWAGE/RADIODISINFESTATION
Dried, irradiated sewage solids as supplemental feed for cattle, 5:24331 (SAND—80-0989C)
SEWAGE/WASTE PRODUCT UTILIZATION
Dried, irradiated sewage solids as supplemental feed for cattle, 5:24331 (SAND—80-0989C)
SEWAGE SLUDGE/WASTE DISPOSAL
Some effects of western coal fly ash on municipal sewage sludge, 5:24313 (METC/SP—79/10(Pt.2))
SEWAGE SLUDGE/WASTE PRODUCT UTILIZATION
Application of fly ash and other wastes to mine soils as an aid in revegetation, 5:23517 (METC/SP—79/10(Pt.2))
SEWAGE TREATMENT
See WASTE PROCESSING
SHADING/BIOLOGICAL EFFECTS
Size and pattern of simulated forest stands, 5:24669
SHALE GAS/IGNITION
Laboratory and fire explosivity testing of oil shale dust, 5:23651
SHALE GAS/PRODUCTION
Energy from in situ processing of antrim oil shale. Quarterly technical progress report, October-December 1979, 5:23627 (FE—2346-58)
Energy from in situ processing of antrim oil shale. Quarterly technical progress report, January-March 1980, 5:23628 (FE—2346-64)
SHALE OIL/GASIFICATION
Production of SNG from shale oil by catalytic gasification in a steam-hydrogen atmosphere, 5:23629 (LETC/RI—79/11)
SHALE OIL/OIL YIELDS
Product yields, 5:23624
SHEATHS (FUEL)
See FUEL CANS
SHIELDING
Analysis of the initial shielding design for the upflow gas-cooled fast reactor (GCFR), 5:24059 (ORNL/TM—7246)
SHIELDING/GAMMA SPECTRA
Integral experiments for fusion reactor design: analysis, 5:25084 (CONF-791058—74)
SHIELDING/MONTE CARLO METHOD
Deep penetration calculations (LMFBR), 5:24057 (LA-UR—80-1159)
SHIELDING/NEUTRON SPECTRA
Integral experiments for fusion reactor design: analysis, 5:25084 (CONF-791058—74)
SHIFT PROCESSES/CATALYSTS
Carbon monoxide shift catalysts and carbonyl sulfide hydrolysis catalysts, 5:23435
SHIPMENT
See TRANSPORT
SHIPS
See also BARGES
SHIPS/DESIGN
Alternative modes of ocean transportation of coal, 5:23548
SHIPS/SIZE
Alternative modes of ocean transportation of coal, 5:23548
Economics of oceanborne coal transportation, 5:23546
SHIVA FACILITY/OPTICAL SYSTEMS
Polarizer reflectivity variations, 5:25076 (UCID—18588)
SHOCK ABSORBERS/DESIGN
Shock absorber for oil well pumping unit (Patent), 5:23584
SHOCK WAVES/TRANSMISSION
Microprocessor-controlled time domain reflectometer for dynamic shock position measurements, 5:24586
SILANES/DECOMPOSITION
Thermal decomposition of silane to form hydrogenated amorphous Si (Patent), 5:24367
SILANES/PHOTOCONDUCTIVITY
Band-tail absorption in hydrogenated amorphous silicon, 5:24477
SILICA/CHEMICAL REACTIONS
Reaction of hydrogen with hydroxyl-free vitreous silica, 5:24469
SILICA/PERMEABILITY
Reaction of hydrogen with hydroxyl-free vitreous silica, 5:24469
SILICA/PRECIPITATION
Improvements in geothermal electric power and silica production (Patent), 5:23991
SILICA/RECOVERY
Improvements in geothermal electric power and silica production (Patent), 5:23991
SILICON/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
SILICON/AMORPHOUS STATE
Amorphous thin films for solar cell application. Final technical report, March 15, 1979-February 29, 1980, 5:23807 (DOE/ET/23040—4)
Thermal decomposition of silane to form hydrogenated amorphous Si (Patent), 5:24367
SILICON/CHEMICAL VAPOR DEPOSITION
Chemical vapor deposition of thin-film polycrystalline Si for low-cost solar cells. First quarterly technical progress report, July 23, 1979-November 2, 1979, 5:23808 (DOE/ET/23045—1)
Development of a polysilicon process based on chemical vapor deposition (Phase 1). First quarterly progress report, 6 October-31 December 1979, 5:23815 (DOE/JPL/955533—79/1)
SILICON/CRYSTAL GROWTH
Sequential purification and crystal growth for the production of low cost silicon substrates. Quarterly technical progress report No. 1, 15 September 1979-31 December 1979, 5:23816 (DOE/SERI—8119-3/1)
SILICON/CRYSTAL LATTICES
X-ray study of lattice strain in boron implanted laser annealed silicon, 5:24478
SILICON/CUTTING
Evaluation of the technical feasibility and effective cost of various wafer thicknesses for the manufacture of solar cells. Final report, July 15, 1978-July 15, 1979, 5:23812 (DOE/JPL/955077—79)
SILICON/DEFECTS
Structural defects in laser- and electron-beam annealed silicon, 5:24374 (CONF-791112—62)
SILICON/ELECTRIC CONDUCTIVITY
Optically induced conductivity changes in discharge-produced hydrogenated amorphous silicon, 5:24467
SILICON/ELECTRICAL PROPERTIES
Amorphous thin films for solar cell application. Final technical report, March 15, 1979-February 29, 1980, 5:23807 (DOE/ET/23040—4)
SILICON/ELECTRON-HOLE DROPLETS
Properties of the one- and two-component electron-hole liquid in stressed Si at T=0, 5:24470
SILICON/EMISSION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
SILICON/EXCITONS
Properties of the one- and two-component electron-hole liquid in stressed Si at T=0, 5:24470
SILICON/IMPURITIES
Silicon materials task of the low cost solar array project (Phase III). Effects of impurities and processing on silicon solar cells. Phase III summary and seventeenth quarterly report, Volume 2: analysis of impurity behavior, 5:23810 (DOE/JPL/954331—80/9(Vol.2))
Silicon materials task of the low cost solar array project (Phase III). Effect of impurities and processing on silicon solar cells. Phase III summary and seventeenth quarterly report, Volume 1: characterization methods for impurities in silicon and impurity effects data base, 5:23809 (DOE/JPL/954331—80/9)
SILICON/ION IMPLANTATION
Infrared reflectiity and transmissivity of boron implanted, laser annealed silicon, 5:24393 (CONF-791112—65)
SILICON/MICROSTRUCTURE
Defect states in plasma-deposited a-Si:H. Final report, February 1979-January 1980, 5:24457 (DOE/ET/23033—16)
Structural defects in laser- and electron-beam annealed silicon, 5:24374 (CONF-791112--62)
SILICON/OPTICAL PROPERTIES
Amorphous thin films for solar cell application. Final technical report, March 15, 1979-February 29, 1980, 5:23807 (DOE/ET/23040—4)

Infrared reflectiity and transmissivity of boron implanted, laser annealed silicon, 5:24393 (CONF-791112—65)
SILICON/PHOTOCONDUCTIVITY
Band-tail absorption in hydrogenated amorphous silicon, 5:24477
Decomposition of silane on tungsten or other materials (Patent), 5:24364
SILICON/POINT DEFECTS
Defect states in plasma-deposited a-Si:H. Final report, February 1979-January 1980, 5:24457 (DOE/ET/23033—16)
SILICON/PRODUCTION
Decomposition of silane on tungsten or other materials (Patent), 5:24364
Development of a polysilicon process based on chemical vapor deposition (Phase 1). First quarterly progress report, 6 October-31 December 1979, 5:23815 (DOE/JPL/955533—79/1)
Thermal decomposition of silane to form hydrogenated amorphous Si (Patent), 5:24367
SILICON/PURIFICATION
Sequential purification and crystal growth for the production of low cost silicon substrates. Quarterly technical progress report No. 1, 15 September 1979-31 December 1979, 5:23816 (DOE/SERI—8119-3/1)
SILICON/SPUTTERING
Amorphous thin films for solar cell application. Final technical report, March 15, 1979-February 29, 1980, 5:23807 (DOE/ET/23040—4)
SILICON/STRAINS
X-ray study of lattice strain in boron implanted laser annealed silicon, 5:24478
SILICON/SURFACE CLEANING
Development of Megasonic cleaning for silicon wafers. Quarterly report No. 4, 5:23814 (DOE/JPL/955342—4)
SILICON/SURFACE PROPERTIES
Numerical methods for the analysis of laser annealing of doped semiconductor wafers, 5:24368 (K/CSD/INF—79/27)
SILICON/X-RAY DIFFRACTION
X-ray study of lattice strain in boron implanted laser annealed silicon, 5:24478
SILICON 28/ENERGY LEVELS
$^{24}Mg(^{16}O,^{12}C)^{28}Si$ and $^{24}Mg(^{16}O,^{16}O)^{24}Mg$ reactions at backward angles, 5:24904
Resonant behavior of the $^{24}Mg(^{16}O,^{12}C)^{28}Si$ reaction, 5:24905
SILICON 28 TARGET/BERYLLIUM 9 REACTIONS
Dominance of strong absorption in $^{9}Be+^{28}Si$ elastic scattering, 5:24903
SILICON 28 TARGET/CARBON 12 REACTIONS
90° excitation functions for elastic scattering of $^{28}Si+^{16}O$ and $^{28}Si+^{12}C$, 5:24908
SILICON 28 TARGET/OXYGEN 16 REACTIONS
90° excitation functions for elastic scattering of $^{28}Si+^{16}O$ and $^{28}Si+^{12}C$, 5:24908
SILICON ALLOYS/MICROSTRUCTURE
Comparative analysis of the cellular and Johnson-Mehl microstructures through computer simulation, 5:24376
SILICON CARBIDES/CORROSION
Refractory materials for coal fueled mhd power generation. Final report, 5:24436 (PB—301095)
SILICON CARBIDES/CRYSTAL GROWTH
Method of forming single crystals of beta silicon carbide (Patent), 5:24426
SILICON CARBIDES/MICROSTRUCTURE
Dependence of silicon carbide coating properties on deposition parameters: preliminary report, 5:24050 (ORNL/TM—7209)
SILICON CARBIDES/NONDESTRUCTIVE TESTING
Development of nondestructive evaluation techniques for high-temperature ceramic heat exchanger components. Tenth quarterly report, January-March 1980, 5:24507 (ANL/MSD/FE—80-2)
SILICON CHLORIDES/SURFACE COATING
Chemical vapor deposition of sialon (Patent), 5:24425
SILICON HYDRIDES
See SILANES
SILICON NITRIDES/BONDING
Chemical vapor deposition of sialon (Patent), 5:24425
Silicon-nitride and metal composite (Patent), 5:24427
SILICON NITRIDES/CORROSION
Refractory materials for coal fueled mhd power generation. Final report, 5:24436 (PB—301095)
SILICON NITRIDES/CORROSION RESISTANCE
Improved structural silicon nitride materials containing rare earth oxides (Patent), 5:24433
Silicon-nitride and metal composite (Patent), 5:24427
SILICON NITRIDES/FABRICATION
Improved structural silicon nitride materials containing rare earth oxides (Patent), 5:24433
SILICON NITRIDES/PHASE DIAGRAMS
Improved structural silicon nitride materials containing rare earth oxides (Patent), 5:24433
SILICON OXIDES/CORROSION
Refractory materials for coal fueled mhd power generation. Final report, 5:24436 (PB—301095)
SILICON OXIDES/CORROSION RESISTANCE
Improved structural silicon nitride materials containing rare earth oxides (Patent), 5:24433
SILICON OXIDES/ELECTRIC CONDUCTIVITY
Electrode module materials evaluation, 5:24223 (FE—2215-13(Vol.1))
SILICON OXIDES/FABRICATION
Improved structural silicon nitride materials containing rare earth oxides (Patent), 5:24433
NASICON: a new solid electrolyte for Na/S batteries, 5:24158
SILICON OXIDES/IONIC CONDUCTIVITY
High Na^+-ion conductivity in $Na_5YSi_4O_{12}$ (25 to 320°C, 3 kHz to 108 MHz), 5:24435
SILICON OXIDES/PHASE DIAGRAMS
Electrode module materials evaluation, 5:24223 (FE—2215-13(Vol.1))
Improved structural silicon nitride materials containing rare earth oxides (Patent), 5:24433
SILICON OXIDES/PRODUCTION
Glass-ceramics for lightning arrestor connector seals, 5:24429 (SAND—80-0215)
SILICON OXIDES/SYNTHESIS
High Na^+-ion conductivity in $Na_5YSi_4O_{12}$ (25 to 320°C, 3 kHz to 108 MHz), 5:24435
SILICON OXIDES/TUNNEL EFFECT
Asymmetry in the SiO_2 tunneling barriers to electrons and holes, 5:24473
SILICON SOLAR CELLS/AMORPHOUS STATE
Amorphous thin films for solar cell application. Final technical report, March 15, 1979-February 29, 1980, 5:23807 (DOE/ET/23040—4)
SILICON SOLAR CELLS/ELECTRIC CONDUCTIVITY
Optically induced conductivity changes in discharge-produced hydrogenated amorphous silicon, 5:24467
SILICON SOLAR CELLS/ELECTRIC CURRENTS
Reverse current-voltage characteristics of indium tin oxide/silicon solar cells under illumination, 5:23823
SILICON SOLAR CELLS/ELECTRIC POTENTIAL
Reverse current-voltage characteristics of indium tin oxide/silicon solar cells under illumination, 5:23823
SILICON SOLAR CELLS/FABRICATION
Amorphous thin films for solar cell application. Final technical report, March 15, 1979-February 29, 1980, 5:23807 (DOE/ET/23040—4)
Chemical vapor deposition of thin-film polycrystalline Si for low-cost solar cells. First quarterly technical progress report, July 23, 1979-November 2, 1979, 5:23808 (DOE/ET/23045—1)
Evaluation of the technical feasibility and effective cost of various wafer thicknesses for the manufacture of solar cells. Final report, July 15, 1978-July 15, 1979, 5:23812 (DOE/JPL/955077—79)
Investigation of proposed process sequence for the array automated assembly task. Phase II. Quarterly technical progress report, March 28, 1980, 5:23811 (DOE/JPL/954853—80/9)
Overview of thick-film technology as applied to solar cells, 5:23821 (SERI/TP—331-541)
Silicon solar cell process development, fabrication and analysis. Fifth quarterly report, October 1, 1979-December 31, 1979, 5:23813 (DOE/JPL/955089—80/6)
SILICON SOLAR CELLS/GRAIN BOUNDARIES
Improvement of polycrystalline silicon solar cells with grain-boundary hydrogenation techniques, 5:23822
SILICON SOLAR CELLS/HYDROGENATION
Improvement of polycrystalline silicon solar cells with grain-boundary hydrogenation techniques, 5:23822
SILICON SOLAR CELLS/IMPURITIES
Silicon materials task of the low cost solar array project (Phase III). Effects of impurities and processing on silicon solar cells. Phase III summary and seventeenth quarterly report, Volume 2: analysis of impurity behavior, 5:23810 (DOE/JPL/954331—80/9(Vol.2))
Silicon materials task of the low cost solar array project (Phase III). Effect of impurities and processing on silicon solar cells. Phase III summary and seventeenth quarterly report, Volume 1: characterization methods for impurities in silicon and impurity effects data base, 5:23809 (DOE/JPL/954331—80/9)
SILICON SOLAR CELLS/PERFORMANCE
Evaluation of the technical feasibility and effective cost of various wafer thicknesses for the manufacture of solar cells. Final report, July 15, 1978-July 15, 1979, 5:23812 (DOE/JPL/955077—79)
Silicon solar cell process development, fabrication and analysis. Fifth quarterly report, October 1, 1979-December 31, 1979, 5:23813 (DOE/JPL/955089—80/6)

SILICONES/STRESS RELAXATION
Stress relaxation of cellular silicone material, 5:24445 (BDX—613-2399)
SILVER/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
SILVER/ACTIVATION ANALYSIS
Activation analysis, 5:24485
Instrumental analysis of trace elements in thumbnails of human subjects, 5:24484
SILVER/SORPTIVE PROPERTIES
Low energy electron diffraction (LEED) study of the adsorption of acetic acid and propanoic acid on Ag(111) and Pt(111), 5:24406
SILVER 109 TARGET/ARGON 40 REACTIONS
Decay of deformed and superdeformed nuclei formed in heavy ion reactions, 5:24910
SILVER COMPLEXES/OXIDATION
Oxidation of Ag^+ and $Ag(NH_3)_2^+$ as studied by pulse radiolysis, 5:24502
SILVER COMPLEXES/RADIOLYSIS
Oxidation of Ag^+ and $Ag(NH_3)_2^+$ as studied by pulse radiolysis, 5:24502
SILVER COMPOUNDS/OXIDATION
Oxidation of Ag^+ and $Ag(NH_3)_2^+$ as studied by pulse radiolysis, 5:24502
SILVER COMPOUNDS/RADIOLYSIS
Oxidation of Ag^+ and $Ag(NH_3)_2^+$ as studied by pulse radiolysis, 5:24502
SILVER NITRATES/ELECTROLYSIS
Electrolysis of molten $NaNO_3$-$AgNO_3$ as test of a model of transport in batteries, 5:24122 (CONF-781063—7)
SILVER-HYDROGEN BATTERIES/DESIGN
Silver-hydrogen cells (35 Ah, 90 Wh/kg, >1000 cycles), 5:24113
SILVER-HYDROGEN BATTERIES/TESTING
Silver-hydrogen cells (35 Ah, 90 Wh/kg, >1000 cycles), 5:24113
SILVER-ZINC BATTERIES/ANODES
Substitutes for mercury in alkaline zinc batteries (II) (850 Ah), 5:24167
SILVER-ZINC BATTERIES/BATTERY SEPARATORS
Heat and chemically resistant membranes (Polyphenylquinoxaline + polar organic polymer), 5:24166
Long-term storage effects on sealed Ag-Zn cells (Approx. 40 Ah), 5:24139
SILVER-ZINC BATTERIES/DESIGN
Long-life rechargeable silver-zinc battery (12 V, 40 Ah), 5:24115
SILVER-ZINC BATTERIES/PERFORMANCE
Long-life rechargeable silver-zinc battery (12 V, 40 Ah), 5:24115
Long-term storage effects on sealed Ag-Zn cells (Approx. 40 Ah), 5:24139
SILVER-ZINC BATTERIES/STORAGE
Long-term storage effects on sealed Ag-Zn cells (Approx. 40 Ah), 5:24139
SIMULATORS/DESIGN
Design and performance of an 11 kW Solar Array Simulator, 5:23852 (SAND—80-0873C)
SIMULATORS/PERFORMANCE
Design and performance of an 11 kW Solar Array Simulator, 5:23852 (SAND—80-0873C)
Wind energy system time-domain (WEST) analyzers using hybrid simulation techniques, 5:24004 (DOE/NASA/0026—79/1)
SINE-GORDON EQUATION/CONSERVATION LAWS
Simple connection between conservation laws in the Korteweg—de Vriesand sine-Gordon systems, 5:24877
SKELETON/BIOLOGICAL RADIATION EFFECTS
Osteosarcomas among beagles exposed to ^{239}Plutonium. Technical report No. 34, 5:24751 (DOE/EV/02874—68)
SKELETON/ISOTOPE DATING
Site 32sn102, Stutsman County, North Dakota: a description and analysis. Final report August-December 1978, 5:24781 (PB—299924)
SKELETON/RADIONUCLIDE KINETICS
Curium-243,4 in the tissues of the adult baboon (Time-dependent effects of DTPA administration on excretion), 5:24757 (COO—3382-18)
Distribution and retention of ^{243} ^{4}Cm in the adult baboon, 5:24756 (COO—3382-18)
Metabolism of americium-241 in man: an unusual case of internal contamination of a child and his father, 5:24752 (COO—3382-18)
Short term kinetics of uranium in the adult baboon: preliminary data, 5:24760 (COO—3382-18)
SLAGS/CHEMICAL COMPOSITION
Electrode module materials evaluation, 5:24223 (FE—2215-13(Vol.1))
Recovery of resource materials from coal ash, 5:23470 (METC/SP—79/10(Pt.1))
SLAGS/CORROSIVE EFFECTS
Materials technology for coal-conversion processes. Nineteenth report, July-December 1979, 5:23417 (ANL—80-12)
SLAGS/MATERIALS RECOVERY
Recovery of resource materials from coal ash, 5:23470 (METC/SP—79/10(Pt.1))
SLAGS/PRODUCTION
Engineering approach for using power plant ash in a structural fill, 5:23497 (METC/SP—79/10(Pt.2))
SLAGS/WASTE PRODUCT UTILIZATION
Fly ash/boiler slag road bases, 5:23501 (METC/SP—79/10(Pt.2))
Impact of proposed RCRA regulations on resource recovery and utilization, 5:23463 (METC/SP—79/10(Pt.1))
Slag: a useful form of ash, 5:24312 (METC/SP—79/10(Pt.2))
SLAT TYPE COLLECTORS/HEAT LOSSES
Natural convection heat transfer in small and moderate aspect ratio enclosures: an application to flat plate collectors, 5:23973
SLAT TYPE COLLECTORS/NATURAL CONVECTION
Natural convection heat transfer in small and moderate aspect ratio enclosures: an application to flat plate collectors, 5:23973
SLUDGES
See SLURRIES
SLUDGES/CHEMICAL COMPOSITION
Recovery of resource materials from coal ash, 5:23470 (METC/SP—79/10(Pt.1))
SLUDGES/LEACHING
Estimating the leaching potential of coal combustion by-products, 5:23483 (METC/SP—79/10(Pt.2))
SLUDGES/MATERIALS RECOVERY
Engineering analysis and comparison of new processes for the recovery of resource materials from coal ash (Lime-soda, salt-soda, nitric acid, Calsinter and Bayer processes), 5:23465 (METC/SP—79/10(Pt.1))
Recovery of resource materials from coal ash, 5:23470 (METC/SP—79/10(Pt.1))
SLUDGES/PHYSICAL PROPERTIES
Characterization of flue gas cleaning (FGC) wastes from coal combustion, 5:23480 (METC/SP—79/10(Pt.1))
SLUDGES/REVIEWS
Characterization of flue gas cleaning (FGC) wastes from coal combustion, 5:23480 (METC/SP—79/10(Pt.1))
SLUDGES/STABILIZATION
By-product-utilization/ultimate-disposal of gas cleaning wastes from coal-fired power generation, 5:23477 (METC/SP—79/10(Pt.1))
Characterization of flue gas cleaning (FGC) wastes from coal combustion, 5:23480 (METC/SP—79/10(Pt.1))
Largest use of fly ash-scrubber sludge disposal, 5:23476 (METC/SP—79/10(Pt.1))
SLUDGES/WASTE DISPOSAL
Disposal of high alkaline fly ash sludge in a decoaled mine seam, 5:23505 (METC/SP—79/10(Pt.2))
Largest use of fly ash-scrubber sludge disposal, 5:23476 (METC/SP—79/10(Pt.1))
Utilization of ash and scrubber sludge in agriculture: a systems study, 5:23506 (METC/SP—79/10(Pt.2))
SLUDGES/WASTE PRODUCT UTILIZATION
Impact of proposed RCRA regulations on resource recovery and utilization, 5:23463 (METC/SP—79/10(Pt.1))
Utilization of ash and scrubber sludge in agriculture: a systems study, 5:23506 (METC/SP—79/10(Pt.2))
SLUGS (FUEL)
See FUEL RODS
SLURRIES/PUMPING
Catalytic biomass liquefaction, 5:23836 (LBL—10667)
SLURRIES (FUEL)
See FUEL SLURRIES
SLURRY PIPELINES/COMPARATIVE EVALUATIONS
Economic considerations of rail and pipeline transportation of coal, 5:23549
SNAP 21 BATTERY/USES
Recent terrestrial and undersea applications of radioisotope thermoelectric generators, 5:23767
SNAP 23 BATTERY/USES
Recent terrestrial and undersea applications of radioisotope thermoelectric generators, 5:23767
SOCIO-ECONOMIC FACTORS/DATA BASE MANAGEMENT
Spatial data on energy, environmental, health, and socio-economic themes at Oak Ridge National Laboratory: 1979 inventory, 5:24175 (ORNL—5636)
SODIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
SODIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))

Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
SODIUM/DENSITY
Extension of liquid-metal theory to dense partially ionized plasmas, 5:24834
SODIUM/EMISSION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
SODIUM/REMOVAL
Evaporative removal of sodium from reactor components, 5:24064
SODIUM/THERMODYNAMIC PROPERTIES
Extension of liquid-metal theory to dense partially ionized plasmas, 5:24834
SODIUM BROMIDES/FINE STRUCTURE
Extended x-ray absorption fine structure of NaBr and Ge at high pressure, 5:24465
SODIUM COMPOUNDS/LATENT HEAT STORAGE
Heat transfer and calorimetric studies of a direct contact-latent heat energy storage system (Disodium hydrogen phosphate), 5:23977
SODIUM COMPOUNDS/PRODUCTION
Preparation of hydrosulfides (Patent), 5:24456
SODIUM NITRATES/ELECTROLYSIS
Electrolysis of molten $NaNO_3$-$AgNO_3$ as test of a model of transport in batteries, 5:24122 (CONF-781063—7)
SODIUM NITRATES/PHASE DIAGRAMS
Phase diagram of $NaNO_3$/KNO_3, 5:24458 (SAND—80-8502)
SODIUM OXIDES/FABRICATION
NASICON: a new solid electrolyte for Na/S batteries, 5:24158
SODIUM OXIDES/IONIC CONDUCTIVITY
High Na^+-ion conductivity in $Na_5YSi_4O_{12}$ (25 to 320°C, 3 kHz to 108 MHz), 5:24435
SODIUM OXIDES/PRODUCTION
Glass-ceramics for lightning arrestor connector seals, 5:24429 (SAND—80-0215)
SODIUM OXIDES/SYNTHESIS
High Na^+-ion conductivity in $Na_5YSi_4O_{12}$ (25 to 320°C, 3 kHz to 108 MHz), 5:24435
SODIUM SULFATES/LATENT HEAT STORAGE
Heat transfer and calorimetric studies of a direct contact-latent heat energy storage system, 5:23977
SODIUM-SULFUR BATTERIES/BATTERY CHARGERS
System and method for charging electrochemical cells in series (Patent application), 5:24154
SODIUM-SULFUR BATTERIES/CATHODES
Sodium-sulfur battery: a progress report (1 MW), 5:24160
Structure of the sulfur electrode in sodium-sulfur cells and comparison with model predictions, 5:24159
SODIUM-SULFUR BATTERIES/PERFORMANCE
Current status of the hollow fiber sodium-sulfur cell (0.5- and 5-Ah), 5:24124
SODIUM-SULFUR BATTERIES/SOLID ELECTROLYTES
High Na^+-ion conductivity in $Na_5YSi_4O_{12}$, 5:24435
NASICON: a new solid electrolyte for Na/S batteries, 5:24158
SOIL CONSERVATION/MATHEMATICAL MODELS
National environmental models of agricultural policy, land use and water quality. Progress report no. 4, 5:24649 (PB—300525)
SOIL MECHANICS/MEETINGS
Microzonation for safer construction-research and application. Proceedings of International Conference (2nd), held at San Francisco, California on November 26-December 1, 1978. Volume I, 5:24783 (PB—301144)
SOILS/ION EXCHANGE
Regional ecological assessment approach to atmospheric deposition: effects on soil systems (Sensitivity of soils in eastern US to acid rain), 5:24643 (CONF-791090—7)
SOILS/PH VALUE
Regional ecological assessment approach to atmospheric deposition: effects on soil systems (Sensitivity of soils in eastern US to acid rain), 5:24643 (CONF-791090—7)
SOILS/PHYSICAL PROPERTIES
Soil profiles of mounds on plutonium-contaminated areas of the Nevada Test Range Complex, 5:24641 (EMSL-LV—0539-33)
SOILS/RADIOACTIVITY
Environmental sampling program for a solar evaporation pond for liquid radioactive wastes, 5:23729 (LA—8177)
Studies of long-term ecological effects of exposure to uranium V, 5:24647 (LA—8221)
SOILS/SORPTIVE PROPERTIES
Adsorption of enteroviruses to soil cores and their subsequent elution by artificial rainwater, 5:24726
SOILS/STABILIZATION
Delayed compaction of high calcium fly ash stabilized soil, 5:23499 (METC/SP—79/10(Pt.2))
Lime/fly ash injection applications, 5:23508 (METC/SP—79/10(Pt.2))
The application of brown coal fly ash to road base courses. Final report (Poland), 5:24318 (PB—300879)
SOLAR ABSORBERS/FABRICATION
Preparation of thin films for solar energy utilization, 5:23825
SOLAR ABSORBERS/MATERIALS
National solar optical materials program plan: an overview, 5:23961 (SERI/TP—641-619)
SOLAR ABSORBERS/SPECTRALLY SELECTIVE SURFACES
Survey of selective solar absorbers and their limitations, 5:23954 (SAND—79-2371C)
SOLAR AIR CONDITIONERS/ABSORPTION REFRIGERATION CYCLE
Development of solar driven absorption air conditioners and heat pumps, 5:23888 (LBL—10771)
SOLAR AIR CONDITIONERS/CONTROL SYSTEMS
Adaptive control for energy conservation, 5:23884 (LA-UR—80-693)
SOLAR AIR CONDITIONERS/RESEARCH PROGRAMS
Development of solar driven absorption air conditioners and heat pumps, 5:23888 (LBL—10771)
SOLAR AIR HEATERS
Solar air systems for space heating, 5:23894
SOLAR AIR HEATERS/DESIGN
Development of a site-fabricated, building integrated air collector. Quarterly technical progress report, September 30, 1977-December 31, 1977, 5:23947 (ALO—4123-T2)
Development of a site-fabricated, building integrated air collector. Interim report, September 30, 1077-March 31, 1978, 5:23948 (ALO—4123-T3)
Development of a site-fabricated building integrated air collector. Third quarterly report, March 31-June 30, 1978, 5:23946 (ALO—4123-T1)
SOLAR AIR HEATERS/PERFORMANCE
Development of a site-fabricated, building integrated air collector. Quarterly technical progress report, September 30, 1977-December 31, 1977, 5:23947 (ALO—4123-T2)
Development of a site-fabricated, building integrated air collector. Interim report, September 30, 1077-March 31, 1978, 5:23948 (ALO—4123-T3)
Development of a site-fabricated building integrated air collector. Third quarterly report, March 31-June 30, 1978, 5:23946 (ALO—4123-T1)
SOLAR CELL ARRAYS
See also COMBINED COLLECTORS
PHOTOVOLTAIC POWER SUPPLIES
SOLAR CELL ARRAYS/SIMULATION
Design and performance of an 11 kW Solar Array Simulator, 5:23852 (SAND—80-0873C)
SOLAR CELLS
See also CADMIUM SULFIDE SOLAR CELLS
CADMIUM TELLURIDE SOLAR CELLS
CONCENTRATOR SOLAR CELLS
GALLIUM ARSENIDE SOLAR CELLS
INDIUM PHOSPHIDE SOLAR CELLS
ORGANIC SOLAR CELLS
SILICON SOLAR CELLS
Infrared reflectiity and transmissivity of boron implanted, laser annealed silicon, 5:24393 (CONF-791112—65)
Therapeutic adornments utilizing solar cells (Patent), 5:23854
SOLAR CELLS/DESIGN
Amorphous lead dioxide photovoltaic generator (Patent), 5:23831
Glass support light energy converter (Patent), 5:23830
SOLAR CELLS/ELECTROPHORESIS
Solar photovoltaic module degradation from electro-migration, 5:23805 (COO—4094-64)
SOLAR CELLS/ENVIRONMENTAL IMPACTS
Environmental, Health, and Safety Considerations, 5:23803 (BNL—27720)
SOLAR CELLS/FABRICATION
Glass support light energy converter (Patent), 5:23830
SOLAR CELLS/HAZARDS
Environmental, Health, and Safety Considerations, 5:23803 (BNL—27720)
SOLAR CELLS/PERFORMANCE TESTING
An analysis of the influence of cell parameters and the spectral content of incident light on the performance of Cu2S-CdS solar cells. Technical report, 5:23819 (PB—301050)
SOLAR CELLS/PHOTOCONDUCTIVITY
Band-tail absorption in hydrogenated amorphous silicon, 5:24477
SOLAR CELLS/PROCUREMENT
Photovoltaic procurement strategies: an assessment of supply issues, 5:23853 (SERI/TR—352-298)
SOLAR CELLS/SEMICONDUCTOR MATERIALS
Cuprous oxide photovoltaic cells. Third quarterly technical progress report, October 9, 1979-January 8, 1980, 5:23806 (DOE/ET/23010—12)
SOLAR CELLS/WEATHERING
Solar photovoltaic module degradation from electro-migration, 5:23805 (COO—4094-64)

SOLAR COLLECTORS
See also COMBINED COLLECTORS
CONCENTRATING COLLECTORS
EVACUATED TUBE COLLECTORS
FLAT PLATE COLLECTORS
PARABOLIC TROUGH COLLECTORS
SLAT TYPE COLLECTORS
SOLAR AIR HEATERS
SOLAR PONDS
TOWER FOCUS COLLECTORS
TRICKLE-TYPE COLLECTORS

SOLAR COLLECTORS/HEAT TRANSFER
Thermal storage and heat transfer in solar energy systems, 5:23975

SOLAR COLLECTORS/INFRARED THERMOGRAPHY
Thermogram analysis of several solar collector arrays, 5:23969

SOLAR COLLECTORS/OPTICAL PROPERTIES
Summary of solar experience with the soiling of optical surfaces, 5:23959 (SERI/TP—334-478)

SOLAR COLLECTORS/PERFORMANCE TESTING
Test experience at the DOE/Sandia Midtemperature Solar Systems Test Facility, 5:23956 (SERI/TP—333-429)

SOLAR COLLECTORS/SURFACE CLEANING
Summary of solar experience with the soiling of optical surfaces, 5:23959 (SERI/TP—334-478)

SOLAR CONCENTRATORS
See also COMPOUND PARABOLIC CONCENTRATORS
FRESNEL LENS
LUMINESCENT CONCENTRATORS
SOLAR REFLECTORS

SOLAR CONCENTRATORS/DESIGN
Image collapsing concentrators. Interim scientific report No. 2, 5:23951 (DOE/CS/34163—2)

SOLAR CONCENTRATORS/OPTICS
Optics of nonimaging concentrators. Light and solar energy (Book), 5:23971

SOLAR COOLING SYSTEMS
See also SOLAR AIR CONDITIONERS

SOLAR COOLING SYSTEMS/CHEMICAL HEAT PUMPS
Sulfuric acid and water chemical heat pump/chemical energy storage program. Phase II-A. Final report, 5:23892 (SAND—78-8176)

SOLAR COOLING SYSTEMS/DESIGN
Solar adaptation of dome structures, 5:23897

SOLAR COOLING SYSTEMS/MEASURING INSTRUMENTS
Monitoring the performance of solar heated and cooled buildings. Volume 2. Measuring instruments - selection, calibration and installation. Final report, 5:23882 (EPRI-ER—1239(Vol.4))

SOLAR COOLING SYSTEMS/MEETINGS
Department of Energy's regional solar updates 1979. Volume two. Invited papers and appendices, 5:23878 (CONF-790758—(Vol.II))

SOLAR COOLING SYSTEMS/PERFORMANCE
Monitoring the performance of solar heated and cooled buildings. Volume 2. Measuring instruments - selection, calibration and installation. Final report, 5:23882 (EPRI-ER—1239(Vol.4))

SOLAR COOLING SYSTEMS/RESEARCH PROGRAMS
Overview-absorption/Rankine solar cooling program, 5:23887 (LBL—10770)

SOLAR DRYERS/DESIGN
Application of solar energy to continuous belt dehydration, 5:23924 (SERI/TP—333-429)

SOLAR DRYERS/PERFORMANCE
Analysis of the operation of an industrial drying solar system, 5:23921 (SERI/TP—333-429)
Performance of a solar heating system for kiln drying lumber, 5:23922 (SERI/TP—333-429)
Review of four DOE-sponsored solar dehydration systems, 5:23906 (SERI/TP—333-429)
Solar augmented soybean drying, 5:23923 (SERI/TP—333-429)

SOLAR DRYING
Scattergood School solar heating system, 5:23898
Textile drying at WestPoint Pepperell using solar process steam, 5:23925 (SERI/TP—333-429)

SOLAR ELECTRONS/INTERPLANETARY SPACE
Impulsive 2—10 keV solar electron events not associated with flares, 5:24797

SOLAR ENERGY/ENERGY SOURCE DEVELOPMENT
Solar energy in Europe, 5:23796

SOLAR ENERGY/FINANCIAL INCENTIVES
Selected federal tax and non-tax subsidies for energy use and production. Energy policy study, Volume 6. AR/EA/80-01, 5:24202 (DOE/EIA—0201/6)

SOLAR ENERGY/LEGISLATION
Legislation, 5:23800

SOLAR ENERGY/MEETINGS
Iowa solar operational results conference, 5:23871

SOLAR ENERGY/REGULATIONS
Analysis of PURPA and solar energy, 5:23799 (SERI/TR—434-484)

SOLAR ENERGY/RESEARCH PROGRAMS
Overview of DOE's solar energy programs, 5:23795

SOLAR ENERGY CONVERSION
Air pressure differential energy system (Patent), 5:24014

SOLAR ENERGY CONVERSION/FERROELECTRIC CONVERTERS
Pyroelectric apparatus including effectively intrinsic semiconductor for converting radiant energy into electric energy (Patent), 5:23802

SOLAR ENERGY CONVERSION/THERMIONIC CONVERTERS
Solar-powered thermionic-photoelectric generator using laser, 5:24231

SOLAR FLARES/INTERPLANETARY SPACE
Impulsive 2—10 keV solar electron events not associated with flares, 5:24797

SOLAR HEAT ENGINES/DESIGN
Optically driven solar engine (Patent), 5:23857

SOLAR HEATING SYSTEMS
See also PASSIVE SOLAR HEATING SYSTEMS
SOLAR-ASSISTED HEAT PUMPS
Solar air systems for space heating, 5:23894

SOLAR HEATING SYSTEMS/CHEMICAL HEAT PUMPS
Sulfuric acid and water chemical heat pump/chemical energy storage program. Phase II-A. Final report, 5:23892 (SAND—78-8176)

SOLAR HEATING SYSTEMS/CONTROL SYSTEMS
Adaptive control for energy conservation, 5:23884 (LA-UR—80-693)

SOLAR HEATING SYSTEMS/DATA ACQUISITION SYSTEMS
Suncatcher Monitoring Project. Quarterly technical report 1, October-December 1977, 5:23880 (DOE/CS/34154—1)

SOLAR HEATING SYSTEMS/DESIGN
Development of a site-fabricated, building integrated air collector. Quarterly technical progress report, September 30, 1977-December 31, 1977, 5:23947 (ALO—4123-T2)
Development of a site-fabricated, building integrated air collector. Interim report, September 30, 1077-March 31, 1978, 5:23948 (ALO—4123-T3)
Development of a site-fabricated building integrated air collector. Third quarterly report, March 31-June 30, 1978, 5:23946 (ALO—4123-T1)
Longfellow solar demonstration project, 5:23901
Solar adaptation of dome structures, 5:23897
Solar-assisted low energy dwellings, 5:23879 (DOE/CS—T0145)
Using a collector 24 hours a day, 5:23895

SOLAR HEATING SYSTEMS/LATENT HEAT STORAGE
Active solar space heating utilizing phase change storage, 5:23896

SOLAR HEATING SYSTEMS/MARKET
Residential solar home resale analysis, 5:23885 (LA-UR—80-1014)

SOLAR HEATING SYSTEMS/MEASURING INSTRUMENTS
Monitoring the performance of solar heated and cooled buildings. Volume 2. Measuring instruments - selection, calibration and installation. Final report, 5:23882 (EPRI-ER—1239(Vol.4))

SOLAR HEATING SYSTEMS/MEETINGS
Department of Energy's regional solar updates 1979. Volume two. Invited papers and appendices, 5:23878 (CONF-790758—(Vol.II))

SOLAR HEATING SYSTEMS/MONITORING
Suncatcher Monitoring Project. Quarterly technical reports 2 and 3, January-June 1978, 5:23881 (DOE/CS/34154—2-3)

SOLAR HEATING SYSTEMS/PERFORMANCE
Development of a site-fabricated, building integrated air collector. Quarterly technical progress report, September 30, 1977-December 31, 1977, 5:23947 (ALO—4123-T2)
Development of a site-fabricated, building integrated air collector. Interim report, September 30, 1077-March 31, 1978, 5:23948 (ALO—4123-T3)
Development of a site-fabricated building integrated air collector. Third quarterly report, March 31-June 30, 1978, 5:23946 (ALO—4123-T1)
Monitoring the performance of solar heated and cooled buildings. Volume 2. Measuring instruments - selection, calibration and installation. Final report, 5:23882 (EPRI-ER—1239(Vol.4))
Performance of a packaged solar space-heating system used with a mobile home, 5:23890 (PB—300890)
Scattergood School solar heating system, 5:23898

SOLAR HEATING SYSTEMS/RETROFITTING
Longfellow solar demonstration project, 5:23901

SOLAR HEATING SYSTEMS/SOLAR-ASSISTED HEAT PUMPS
Solar assisted heat pump program overview and summary of work at Brookhaven National Laboratory, 5:23875 (BNL—27662)

SOLAR INDUSTRY/FINANCIAL INCENTIVES
Analysis of federal incentives used to stimulate energy production: an executive summary, 5:24182 (PNL—2410(Rev.2))

SOLAR INDUSTRY/PERSONNEL
Quest for certified slar energy engineering personnel, 5:23801

SOLAR PONDS
Low temperature industrial process heat from non-convecting solar ponds , 5:23957 (SERI/TP—333-429)
SOLAR PONDS/MATHEMATICAL MODELS
Solar pond studies: Phase III. Fifth semiannual progress report to the US Department of Energy, 5:23945 (ALO—3977-5)
SOLAR PONDS/PERFORMANCE
Evaluation of solar pond performance, 5:23953 (MLM—2702(OP))
SOLAR PONDS/REVIEWS
Overview of solar pond technology, 5:23937 (SERI/TP—333-429)
SOLAR PONDS/THERMODYNAMICS
Solar pond studies: Phase III. Fifth semiannual progress report to the US Department of Energy, 5:23945 (ALO—3977-5)
SOLAR PROCESS HEAT
Solar collector and industrial heat pump system for process hot water for an aluminum anodizing line, 5:23936 (SERI/TP—333-429)
Solar industrial process hot water for cement block manufacture, 5:23919 (SERI/TP—333-429)
Solar process water heat for the Iris Images Custom Color Photo Lab. Final report, 5:23904 (DOE/NASA/CR—161414)
SOLAR PROCESS HEAT/DEMONSTRATION PROGRAMS
Application of solar energy for the generation and supply of industrial process low to intermediate pressure steam ranging in temperature from 300°F to 550°F, 5:23929 (SERI/TP—333-429)
High temperature process steam application at the Southern Union Refining Company (solar energy in the oil patch), 5:23932 (SERI/TP—333-429)
New DOE-funded projects, 5:23908 (SERI/TP—333-429)
Review of four DOE-sponsored solar dehydration systems, 5:23906 (SERI/TP—333-429)
Seven DOE intermediate temperature (350°F to 550°F) steam demonstration projects, 5:23907 (SERI/TP—333-429)
Solar production of industrial process hot water (Can washing at Campbell Soup plant), 5:23918 (SERI/TP—333-429)
Solar production of industrial process steam, 5:23926 (SERI/TP—333-429)
Solar production of industrial process steam for The Home Laundry, 5:23927 (SERI/TP—333-429)
Solar production of low pressure steam for processing of orange juice, 5:23928 (SERI/TP—333-429)
Solar production of industrial process steam at Dow Chemical Company's Dalton, Georgia, Latex Manufacturing Plant, 5:23930 (SERI/TP—333-429)
Solar production of industrial process steam for the Lone Star Brewery, 5:23933 (SERI/TP—333-429)
Solar production of industrial process steam for Stauffer Chemical Company, 5:23934 (SERI/TP—333-429)
Solar production of industrial process steam for potato frying, 5:23935 (SERI/TP—333-429)
Solar supplement to laundry drying, 5:23915 (SERI/TP—333-429)
SOLAR PROCESS HEAT/ECONOMIC ANALYSIS
Economic analysis of solar industrial process heat systems: a methodology to determine annual required revenue and internal rate of return, 5:23940 (SERI/TP—333-429)
Economic viability of the solar-assisted industrial heat pump system, 5:23912 (SERI/TP—333-429)
Solar industrial process steam: an economic analysis, 5:23909 (SERI/TP—333-429)
SOLAR PROCESS HEAT/ECONOMICS
Analysis of the operation of an industrial drying solar system, 5:23921 (SERI/TP—333-429)
Central receiver solar energy system for an oil refinery, 5:23917 (SERI/TP—333-429)
Solar-industrial heat for New York State: a case study in regional impact on economic viability, 5:23911 (SERI/TP—333-429)
SOLAR PROCESS HEAT/FEASIBILITY STUDIES
Potential for the use of solar energy in the production of process heat in Arizona, 5:23916 (SERI/TP—333-429)
Solar production of industrial process steam (NL Industries, Inc. Project; Newberry Springs, California) (Processing hectorite ore), 5:23931 (SERI/TP—333-429)
SOLAR PROCESS HEAT/GOVERNMENT POLICIES
Implications of meeting the domestic policy review's goal for solar industrial process heat in the year 2000, 5:23914 (SERI/TP—333-429)
SOLAR PROCESS HEAT/MARKETING RESEARCH
Industrial applications analysis: market characterization and system definition for several industries, 5:23910 (SERI/TP—333-429)
SOLAR PROCESS HEAT/MEETINGS
Solar industrial process heat conference proceedings, 5:23905 (SERI/TP—333-429)
SOLAR PROCESS HEAT/PARABOLIC DISH COLLECTORS
Point-focus collector technology for IPH, 5:23938 (SERI/TP—333-429)
SOLAR PROCESS HEAT/REVIEWS
IPS system configurations, 5:23939 (SERI/TP—333-429)
SOLAR PROCESS HEAT/SOLAR PONDS
Low temperature industrial process heat from non-convecting solar ponds , 5:23957 (SERI/TP—333-429)
Overview of solar pond technology, 5:23937 (SERI/TP—333-429)
SOLAR PROCESS HEAT/SOLAR WATER HEATERS
Operational experience of the LaFrance, South Carolina solar process hot water system, 5:23920 (SERI/TP—333-429)
SOLAR PROCESS HEAT/SOLAR-ASSISTED HEAT PUMPS
Economic viability of the solar-assisted industrial heat pump system, 5:23912 (SERI/TP—333-429)
SOLAR PROCESS HEAT/SURVEYS
Gas Research Institute's solar-augmented applications in industry program, 5:23913 (SERI/TP—333-429)
SOLAR PROCESS HEAT/TOWER FOCUS COLLECTORS
Central receiver solar energy system for an oil refinery, 5:23917 (SERI/TP—333-429)
SOLAR REFLECTORS
See also PARABOLIC REFLECTORS
SOLAR REFLECTORS/ELECTRIC CONTACTS
Preparation of thin films for solar energy utilization, 5:23825
SOLAR REFLECTORS/MATERIALS
National solar optical materials program plan: an overview, 5:23961 (SERI/TP—641-619)
Properties of a solar alumina-borosilicate sheet glass, 5:23960 (SERI/TP—334-565)
SOLAR RIGHTS
Land use controls to save energy, 5:24260
SOLAR SPACE HEATING/ELECTRIC POWER
Electric utilities and residential solar systems, 5:23877 (BNL—27711)
SOLAR THERMAL POWER PLANTS
See also DISTRIBUTED COLLECTOR POWER PLANTS
TOWER FOCUS POWER PLANTS
SOLAR THERMAL POWER PLANTS/DEMONSTRATION PROGRAMS
DOE Solar Thermal Power Systems Program, 5:23856 (SERI/TP—333-429)
SOLAR THERMAL POWER PLANTS/NET ENERGY
Comparative analysis of net energy balance for satellite power systems (SPS) and other energy systems, 5:23850 (DOE/ER—0056)
SOLAR THERMAL POWER PLANTS/RESEARCH PROGRAMS
DOE Solar Thermal Power Systems Program, 5:23856 (SERI/TP—333-429)
SOLAR TRACKING/EQUIPMENT
Solar tracking system for line focusing collectors, 5:23955 (SERI/TP—333-429)
SOLAR WATER HEATERS/DESIGN
Design and evaluation of solar powered residential domestic water heaters, 5:23943
Solar hot water preheater kit: problems, economics, performance, 5:23872
SOLAR WATER HEATERS/EVALUATION
Design and evaluation of solar powered residential domestic water heaters, 5:23943
SOLAR WATER HEATERS/HEAT EXCHANGERS
Innovative double walled heat exchanger for use in solar water heating, 5:23944
SOLAR WATER HEATERS/OPERATION
Experience with solar heating, 5:23942
Solar hot water preheater kit: problems, economics, performance, 5:23872
SOLAR WATER HEATERS/PERFORMANCE
Scattergood School solar heating system, 5:23898
Solar energy system performance evaluation, Hogate's Restaurant, Washington, DC, June-August, 1978, 5:23941 (SOLAR/2028—78/14)
SOLAR WATER HEATING/ELECTRIC POWER
Electric utilities and residential solar systems, 5:23877 (BNL—27711)
SOLAR WIND/HEAVY IONS
Solar wind flows associated with hot heavy ions, 5:24796 (LA—8344-T)
SOLAR WIND/PLASMA ACCELERATION
Solar wind ions accelerated to 40 keV by shock wave disturbances, 5:24798
SOLAR-ASSISTED HEAT PUMPS/ECONOMIC ANALYSIS
Economic viability of the solar-assisted industrial heat pump system, 5:23912 (SERI/TP—333-429)
SOLAR-ASSISTED HEAT PUMPS/FEASIBILITY STUDIES
Feasibility study on a combined summer cooling and winter heating system, based on a combination of solar energy and ground heat pumps, 5:23883 (EUR—6701)
Hybrid photovoltaic/thermal systems with a solar-assisted heat pump, 5:23876 (BNL—27667)

SOLAR-ASSISTED HEAT PUMPS/RESEARCH PROGRAMS
Solar assisted heat pump program overview and summary of work at Brookhaven National Laboratory, 5:23875 (BNL—27662)
SOLID WASTES
See also AGRICULTURAL WASTES
WOOD WASTES
SOLID WASTES/POLLUTION CONTROL
By-product-utilization/ultimate-disposal of gas cleaning wastes from coal-fired power generation, 5:23477 (METC/SP—79/10(Pt.1))
SOLID WASTES/WASTE DISPOSAL
Boone County field site interim report. Test cells 2A, 2B, 2C, and 2D. Interim report August 1972-December 1976, 5:24648 (PB—299689)
By-product-utilization/ultimate-disposal of gas cleaning wastes from coal-fired power generation, 5:23477 (METC/SP—79/10(Pt.1))
Environmentally acceptable disposal of coal conversion solid waste residuals. Progress report, April 21, 1979-July 31, 1979, 5:23458 (DOE/PC/20023—1)
SOLIDS/MECHANICAL VIBRATIONS
Excitation by light pulses of mechanical vibrations in solids, 5:24468
SOLIDS/PIEZOELECTRICITY
Excitation by light pulses of mechanical vibrations in solids, 5:24468
SOLID-STATE PLASMA/SURFACE ENERGY
Wave-vector decomposition of the exchange and correlation contributions to a metallic surface energy, 5:24967
SOLUTION MINING/REVIEWS
Solution mining of uranium, 5:23699
SOLVENT-REFINED COAL/CHEMICAL COMPOSITION
Separation and structure elucidation of coal molecule fragments. Final report, February 1, 1976-August 31, 1979, 5:23453 (DOE/EV/2856—5)
SOLVENT-REFINED COAL/COMBUSTION PROPERTIES
Treating and feeding SRC to demonstrate its suitability as a gas turbine fuel. Phase II. Final report, 5:23562 (FE—2304-43)
SOLVENT-REFINED COAL/DESULFURIZATION
Upgrading of coal liquids for use as power generation fuels. Final report, February 1978-June 1979, 5:23439 (EPRI-AF—1255)
SOLVENT-REFINED COAL/FRACTIONATION
Separation and structure elucidation of coal molecule fragments. Final report, February 1, 1976-August 31, 1979, 5:23453 (DOE/EV/2856—5)
SOLVENT-REFINED COAL/MATERIALS HANDLING
Treating and feeding SRC to demonstrate its suitability as a gas turbine fuel. Phase II. Final report, 5:23562 (FE—2304-43)
SOLVENT-REFINED COAL/PURIFICATION
Treating and feeding SRC to demonstrate its suitability as a gas turbine fuel. Phase II. Final report, 5:23562 (FE—2304-43)
SOLVENT-REFINED COAL/REFINING
Refining and upgrading of synfuels from coal and oil shales by advanced catalytic processes. Laboratory and Pilot Plant studies of the processing of SRC-I. Second interim report, 5:23446 (FE—2315-45)
SOLVENT-REFINING COAL PLANTS
See COAL PREPARATION PLANTS
SORGHUM/HYDROLYSIS
Carbohydrate crops as a renewable resource for fuels production. Volume III. Juice preservation, 5:23833 (BMI—2031(Vol.3))
SOUTH CAROLINA/POLLUTION REGULATIONS
Motor vehicle emissions inspection/maintenance program for South Carolina. Final report, 5:24352 (PB—300304)
SOUTH DAKOTA/DATA COMPILATION
Aerial gamma ray and magnetic survey: Idaho Project, Nemo Detail Area, South Dakota. Final report, 5:23687 (GJBX—96(80)(Vol.2))
SOUTH DAKOTA/MAGNETIC SURVEYS
Aerial gamma ray and magnetic survey: Idaho Project, Nemo Detail Area, South Dakota. Final report, 5:23686 (GJBX—96(80)(Vol.1))
Aerial gamma ray and magnetic survey: Idaho Project, Nemo Detail Area, South Dakota. Final report, 5:23687 (GJBX—96(80)(Vol.2))
SOUTH DAKOTA/RADIOMETRIC SURVEYS
Aerial gamma ray and magnetic survey: Idaho Project, Nemo Detail Area, South Dakota. Final report, 5:23686 (GJBX—96(80)(Vol.1))
Aerial gamma ray and magnetic survey: Idaho Project, Nemo Detail Area, South Dakota. Final report, 5:23687 (GJBX—96(80)(Vol.2))
SOVIET UNION
See USSR
SOYBEAN PLANT
See GLYCINE HISPIDA
SOYBEANS/INFRARED SURVEYS
Remote sensing of sulfur dioxide effects on vegetation - photometric analysis of aerial photographs, 5:24767 (PB—300460)
SOYBEANS/PRODUCTION
Resource-conserving agricultural production methods. Progress report August 1977-July 1978, 5:24301 (PB—301042)
SOYBEANS/SOLAR DRYING
Review of four DOE-sponsored solar dehydration systems, 5:23906 (SERI/TP—333-429)
Solar augmented soybean drying, 5:23923 (SERI/TP—333-429)
SPACE HEATERS/ENERGY CONSUMPTION
Residential energy consumption survey: characteristics of the housing stock and households, 5:24253 (DOE/EIA—0207/2)
SPACE HEATING
See also ANNUAL CYCLE ENERGY SYSTEM
SPACE HEATING/EMERGENCY PLANS
Community planning for home-heating emergencies: a guide for Community-Action Agencies and other community-based organizations (Booklet), 5:24251 (CSA-PAMPHLET—6143-15)
SPACE LATTICES
See CRYSTAL LATTICES
SPACE VEHICLES/NICKEL-CADMIUM BATTERIES
Sealed nickel cadmium cell design by computer modeling, 5:24111
SPACE VEHICLES/SILVER-ZINC BATTERIES
Long-term storage effects on sealed Ag-Zn cells (Approx. 40 Ah), 5:24139
SPACECRAFT POWER SUPPLIES/COMPARATIVE EVALUATIONS
Comparison of alternate power sources for the MX missile system, 5:24334
SPACECRAFT POWER SUPPLIES/PERFORMANCE
Ram air turbine power supplies for high performance flight vehicles, 5:24339
SPACECRAFT POWER SUPPLIES/SILVER-HYDROGEN BATTERIES
Silver-hydrogen cells (35 Ah, 90 Wh/kg, >1000 cycles), 5:24113
SPARK COUNTERS/DESIGN
New particle detector: a spark counter with localized discharge, 5:24564
SPARK COUNTERS/TIME RESOLUTION
New particle detector: a spark counter with localized discharge, 5:24564
SPECTRALLY SELECTIVE SURFACES/FABRICATION
Preparation of thin films for solar energy utilization, 5:23825
SPECTRALLY SELECTIVE SURFACES/REVIEWS
Survey of selective solar absorbers and their limitations, 5:23954 (SAND—79-2371C)
SPECTROSCOPY
See also AUGER ELECTRON SPECTROSCOPY
SPECTROSCOPY/MEETINGS
Symposium on atomic spectroscopy, 5:24804 (DOE/ER/10460—1)
SPECTROSCOPY/PHOSPHORESCENCE
Room temperature phosphorimetry for the analysis of environmental systems, 5:24651 (CONF-791059—8)
SPENT FUEL CASKS/FIRES
Postmortem metallurgical examination of a fire-exposed spent fuel shipping cask (After impact test), 5:24519 (SAND—79-1424)
SPENT FUEL ELEMENTS/ENCAPSULATION
Method and means of packaging nuclear fuel rods for handling (Patent), 5:24076
SPENT FUEL ELEMENTS/REACTIVITY WORTHS
Reactivity monitoring. Final report, Task 2, 5:23706 (DOE/ET/47906—4)
SPENT FUEL ELEMENTS/TRANSPORT
Method and means of packaging nuclear fuel rods for handling (Patent), 5:24076
SPENT FUEL STORAGE
See also AWAY-FROM-REACTOR STORAGE
Appendices for Department of Energy study on spent nuclear fuel storage (No text), 5:23708 (DOE/SR—0004(Vol.2))
Department of Energy study on spent nuclear fuel storage, 5:23707 (DOE/SR—0004(Vol.1))
Spent fuel storage. Facts booklet, 5:23728 (DOE/NE—0005)
SPENT FUEL STORAGE/CHARGES
Final environmental impact statement: US Spent Fuel Policy. Charge for spent fuel storage, 5:23726 (DOE/EIS—0015(Vol.4))
SPENT FUEL STORAGE/CORROSION
Spent fuel and fuel pool component integrity. Annual report, FY 1979, 5:23709 (PNL—3171)
SPENT FUEL STORAGE/ENVIRONMENTAL IMPACT STATEMENTS
Final environmental impact statement: US Spent Fuel Policy. Executive summary, 5:23723 (DOE/EIS—0015(Vol.1))
Final environmental impact statement: US Spent Fuel Policy. Storage of US spent power reactor fuel, 5:23724 (DOE/EIS—0015(Vol.2))

Final environmental statement: US Spent Fuel Policy. Storage of foreign spent power reactor fuel, 5:23725 (DOE/EIS—0015(Vol.3))
Final environmental impact statement: US Spent Fuel Policy. Charge for spent fuel storage, 5:23726 (DOE/EIS—0015(Vol.4))
Final environmental impact statement: US Spent Fuel Policy. Comment letters on draft statements and major comments with DOE responses, 5:23727 (DOE/EIS—0015(Vol.5))
SPENT FUEL STORAGE/ENVIRONMENTAL IMPACTS
Final environmental impact statement: US Spent Fuel Policy. Storage of US spent power reactor fuel, 5:23724 (DOE/EIS—0015(Vol.2))
Final environmental statement: US Spent Fuel Policy. Storage of foreign spent power reactor fuel, 5:23725 (DOE/EIS—0015(Vol.3))
SPENT FUEL STORAGE/GOVERNMENT POLICIES
Final environmental impact statement: US Spent Fuel Policy. Executive summary, 5:23723 (DOE/EIS—0015(Vol.1))
Final environmental impact statement: US Spent Fuel Policy. Storage of US spent power reactor fuel, 5:23724 (DOE/EIS—0015(Vol.2))
Final environmental statement: US Spent Fuel Policy. Storage of foreign spent power reactor fuel, 5:23725 (DOE/EIS—0015(Vol.3))
Final environmental impact statement: US Spent Fuel Policy. Charge for spent fuel storage, 5:23726 (DOE/EIS—0015(Vol.4))
Final environmental impact statement: US Spent Fuel Policy. Comment letters on draft statements and major comments with DOE responses, 5:23727 (DOE/EIS—0015(Vol.5))
SPENT FUEL STORAGE/HEAT TRANSFER
Advanced three-dimensional thermal modeling of a baseline spent fuel repository, 5:23710 (UCID—18660)
SPENT SHALES/CHEMICAL COMPOSITION
Environmental research on a modified in situ oil shale task process. Progress report, 5:23660 (DOE/EV—0078)
SPENT SHALES/COMPACTING
Spent shale compaction for void volume generation in in situ oil shale processing, 5:23638
SPENT SHALES/HEALTH HAZARDS
Environmental research on a modified in situ oil shale task process. Progress report, 5:23660 (DOE/EV—0078)
SPENT SHALES/MUTAGEN SCREENING
Mutagenicity testing of aqueous materials from alternate fuel production, 5:24765 (CONF-790663—3)
SPENT SHALES/PHYSICAL PROPERTIES
Geotechnical properties of a fine-grained spent shale waste, 5:23645
SPENT SHALES/WASTE DISPOSAL
Review of the environmental impact of ground disposal of oil shale wastes, 5:24645
SPENT SHALES/WASTE PRODUCT UTILIZATION
The use of waste and low-grade materials in road construction. 6. Spent oil shale, 5:23647 (PB—299940)
SPERMATOGONIA/GENE MUTATIONS
Specific-locus test shows ethylnitrosourea to be the most potent mutagen in the mouse, 5:24774
SPHERES/POLISHING
Semiautomated inspection of superfinished spherical surfaces, 5:24508 (BDX—613-2375)
SPHERES/SURFACE FINISHING
Semiautomated inspection of superfinished spherical surfaces, 5:24508 (BDX—613-2375)
SPHEROMAK DEVICES/ION SOURCES
Intense pulsed ion beams for fusion applications, 5:25075 (SAND—80-0402)
SPOIL BANKS/LAND RECLAMATION
Hillman State Park: final assessment of fly ash as a soil modifier for acidic strip mine spoil, 5:23516 (METC/SP—79/10(Pt.2))
SPORES
See also BACTERIAL SPORES
SPORES/AEROSOL MONITORING
Airborne aeroallergen measurements in Houston, Texas. Final report, 5:24602 (PB—299643)
SPRAY PONDS
See COOLING PONDS
SQUID DEVICES/NOISE
All-Nb low-noise dc SQUID with 1-μm tunnel junctions, 5:24516
STACKS/GASEOUS WASTES
Evaluation of stationary source particulate measurement methods. Volume III. Gas temperature control during method 5 sampling. Interim report oct 73-February 1977, 5:24607 (PB—300336)
STACKS/TEMPERATURE MEASUREMENT
Evaluation of stationary source particulate measurement methods. Volume III. Gas temperature control during method 5 sampling. Interim report oct 73-February 1977, 5:24607 (PB—300336)
STAINLESS STEEL-304/CREEP
Cyclic creep of Type 304 stainless steel during unbalanced tension-compression loading at elevated temperature, 5:24388
STAINLESS STEEL-304/DESORPTION
Thermal desorption measurements of hydrogen—isotope retention in the Alcator-A tokamak, 5:25101
STAINLESS STEEL-304/EROSION
Low-energy ion erosion studies of machine faceted stainless steel, 5:24416
STAINLESS STEEL-304/GAMMA SPECTRA
Integral experiments for fusion reactor design: analysis, 5:25084 (CONF-791058—74)
STAINLESS STEEL-304/NEUTRON SPECTRA
Integral experiments for fusion reactor design: analysis, 5:25084 (CONF-791058—74)
STAINLESS STEEL-304/SENSITIVITY
Portable probe to measure sensitization of stainless steel (Patent), 5:24417
STAINLESS STEEL-310/PERMEABILITY
Ion beam technique for the measurement of deuterium diffusion coefficients, 5:24359
STAINLESS STEEL-316/COMPATIBILITY
Reliability and durability study of a thermal receiver utilizing ASI Type 316 stainless steel in contact with molten aluminum, 5:23860 (SERI/TP—641-653)
STAINLESS STEEL-316/PHYSICAL RADIATION EFFECTS
Experimental observations of effects of inert gas on cavity formation during irradiation, 5:24423 (ORNL/TM—7193)
Relationship between swelling and the shear modulus of irradiated metal, 5:24421 (HEDL-SA—1774-FP)
STAINLESS STEEL-316/SENSITIVITY
Portable probe to measure sensitization of stainless steel (Patent), 5:24417
STAINLESS STEEL-316/SWELLING
Relationship between swelling and the shear modulus of irradiated metal, 5:24421 (HEDL-SA—1774-FP)
STAINLESS STEELS
See also STAINLESS STEEL-304
STAINLESS STEEL-310
STAINLESS STEEL-316
STAINLESS STEELS/ELECTROPOLISHING
Effect of container preparation on the growth of protium and methane impurities into tritium gas, 5:25095
STAINLESS STEELS/HOT PRESSING
Process for treating weldments (Patent), 5:24365
STAINLESS STEELS/ION COLLISIONS
Retention and re-emission of 0.125— 1-keV deuterium in stainless steel, 5:24808
STAINLESS STEELS/PHOTOELECTRON SPECTROSCOPY
X-ray photoelectron spectroscopy (XPS) studies of oxygen and carbon bonding to tokamak walls, 5:25098
STAINLESS STEELS/WELDED JOINTS
Process for treating weldments (Patent), 5:24365
STANDARDS/BUILDINGS
LLL calibration and standards facility, 5:24573 (UCRL—84295)
STANDARDS/LABORATORY EQUIPMENT
LLL calibration and standards facility, 5:24573 (UCRL—84295)
STANDING CROP
See BIOMASS
STANFORD LINEAR ACCELERATOR CENTER/RADIATION MONITORING
Annual environmental monitoring report, January-December 1979, 5:24634 (SLAC—228)
STAR ACCRETION/SHOCK WAVES
Formation of solar-type stars in spherical symmetry. I. The key role of the accretion shock, 5:24794
STAR MODELS/OSCILLATION MODES
Theoretical period ratios for RR Lyrae variables and AQ Leonis, 5:24795
STARCH/METABOLISM
Light-dark regulation of starch metabolism in chloroplasts. II. Effect of chloroplastic metabolite levels on the formation of ADP-glucose by chloroplast extracts, 5:24706
STATE GOVERNMENT/ENERGY CONSERVATION
Evaluation of the State Energy Conservation Program from program initiation to September 1978. Final report, 5:24191 (DOE/CS/1697—01)
STATE GOVERNMENT/ENERGY POLICY
Energy policy and research planning. Volume 3. October, 1977-September, 1979 (a bibliography with abstracts). Report for October 1977-September 1979, 5:24205 (NTIS/PS—79/1069)
STATIONARY POLLUTANT SOURCES
(Used for general articles when sources are not named. See also specific stationary sources, e.g., Fossil-fuel Power Plants.)
See also AIR POLLUTION
STATIONARY POLLUTANT SOURCES/AIR POLLUTION CONTROL
Compliance status of major air pollution facilities. Final report, 5:24636 (PB—299959)

Environmental assessment of stationary source NOx control technologies. Annual report no. 2, June 1977-June 1978, 5:24547 (PB—300469)
STATIONARY POLLUTANT SOURCES/ENVIRONMENTAL IMPACTS
Environmental assessment of stationary source NOx control technologies. Annual report no. 2, June 1977-June 1978, 5:24547 (PB—300469)
STATIONARY POLLUTANT SOURCES/INVENTORIES
Inventory of sources with emissions of 25 to 100 tons per year subject to organic material regulations in Metropolitan Boston AQCR. Final report, 5:24618 (PB—301242)
STATIONARY POLLUTANT SOURCES/MONITORING
Continuous air pollution source monitoring systems, 5:24616 (PB—300930)
STATISTICS
See also REGRESSION ANALYSIS
STATISTICS/ERRORS
Note on the robustness of Dixon's ratio test in small samples (Testing for outliers), 5:25111 (ORNL/TM—7265)
STEAM GENERATORS/PERFORMANCE TESTING
Progress of LMFBR steam generator testing in the US, 5:24056 (GEFR-SP—196)
STEAM GENERATORS/SURFACE CLEANING
PWR steam generator chemical cleaning. Phase II. Final report, 5:24046 (COO—4325-02)
STEAM GENERATORS/ULTRASONIC TESTING
Ultrasonic inspection of liquid-metal fast breeder reactor steam generator duplex tubing, 5:24063
STEEL-ASTM-A533-B/CRACKS
Use of acoustic emission for assessing the integrity of a nuclear reactor pressure vessel, 5:24392
STEELS
See also AUSTENITIC STEELS
CARBON STEELS
CHROMIUM STEELS
STAINLESS STEELS
STEELS/EXPLOSION WELDING
Viscosity of metals in explosive welding, 5:24371 (UCRL-Trans—11542)
STEELS/FABRICATION
Alloys for a liquid metal fast breeder reactor (Patent), 5:24372
STEELS/MATERIALS RECOVERY
Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation. Volume II. working papers, 5:24329 (PB—300848)
Materials and energy from municipal waste: resource recovery and recycling from municipal solid waste and beverage container deposit legislation, 5:24330 (PB—300849)
STEELS/PHYSICAL RADIATION EFFECTS
Relating surveillance capsule measurements to pressure vessel damage, 5:24073 (BNL-NUREG—27192)
STEM CELLS/STANDARDIZED TERMINOLOGY
Haemopoietic stem cells: concepts and definitions, 5:24730
STEROID HORMONES/BIOCHEMISTRY
Changes in ecdysteroids during embryogenesis of the blue crab, callinectes sapidus rathbun, 5:24687
STIRLING ENGINES/PERFORMANCE
Design and development of Stirling Engines for stationary power generation applications in the 500 to 3000 hp range. Subtask 1A report: state-of-the-art conceptual design, 5:24010 (DOE/ET/15209—T1)
STIRLING ENGINES/RESEARCH PROGRAMS
Design and development of Stirling Engines for stationary power generation applications in the 500 to 3000 hp range. Subtask 1A report: state-of-the-art conceptual design, 5:24010 (DOE/ET/15209—T1)
STOCHASTIC PROCESSES/SIMULATION
Generation of approximating distributions through the method of stages, 5:25104 (BNL—27513)
STORAGE RINGS
See also ISABELLE STORAGE RINGS
STORAGE RINGS/BEAM OPTICS
Optimization of a synchrotron radiation source, 5:24556 (BNL—27654)
STORAGE (SPENT FUEL)
See SPENT FUEL STORAGE
STORAGE TUBES
See ELECTRON TUBES
STOVER
See AGRICULTURAL WASTES
STRATEGIC PETROLEUM RESERVE
Analysis of Federal Government energy emergency programs. Energy policy study, Volume 5. AR/EI-80-05, 5:24195 (DOE/EIA—0201/5)
STREAMS/AQUATIC ECOSYSTEMS
The biology of salt wells creek and its tributaries, southwestern Wyoming. Water-resources investigations, 5:24659 (PB—300828)
STRESS ANALYSIS/COMPUTER CODES
Analysis of an internally pressurized prismatic cell can, 5:24156 (ANL—80-30)
STRESS (BIOLOGICAL)
See BIOLOGICAL STRESS
STRONG INTERACTIONS
See also HADRON-HADRON INTERACTIONS
STRONG INTERACTIONS/QUARK MODEL
Heavy quarks and new particles, 5:24868
STRONTIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
STRONTIUM 85/BETA DECAY
Level properties of $^{85}_{37}Rb_{48}$ from the decay of the ^{85}Kr and ^{85}Sr isomers and the cluster-vibration model, 5:24913
STRONTIUM 90/SORPTION
Sorption studies at Hanford for the control of radioactive wastes, 5:23740 (RHO-SA—155)
STRONTIUM COMPOUNDS/PRODUCTION
Preparation of hydrosulfides (Patent), 5:24456
SUBCRITICAL FLOW
See LAMINAR FLOW
SUCROSE
See SACCHAROSE
SUGAR BEETS/PROCESS SOLUTIONS
Technical and economic feasibility of membrane technology. Technical progress report, December 17, 1979-March 16, 1980, 5:23834 (BSDF—39-2Q-80)
SULFATES/AERIAL MONITORING
Estimated dry deposition velocities of sulfur over the eastern United States and surrounding regions, 5:24627
SULFATES/BIOLOGICAL EFFECTS
Plant developmental system to measure the impact of pollutants in rain water, 5:24768
SULFATES/PHYSICAL PROPERTIES
Sulfate specifications as a constraint to gypsum addition to cement and possible replacement of gypsum as an additive. Phase I. Final quarterly technical progress report, December 1979-January-February 1980, 5:24292 (DOE/CS/40221—6)
SULFUR/CHEMICAL REACTION KINETICS
Sulfur fixation during coal gasification. Final report 1 March 1975-28 February 1978, 5:23414 (PB—301104)
SULFUR/CHEMISTRY
Sulfur and oxygen chemistry at free surfaces and grain boundaries of iron alloys, 5:24407
SULFUR/RECOVERY
Claus UCAP (integrated UCAP) sulfur recovery, 5:23436
Holmes-Stretford process for desulfurization of tail gases from acid-gas systems, 5:23415
SULFUR/SEGREGATION
Sulfur and oxygen chemistry at free surfaces and grain boundaries of iron alloys, 5:24407
SULFUR 32 TARGET/NEUTRON REACTIONS
Neutron total cross section of sulfur: Single level to multilevel to optical model, 5:24902
SULFUR 34 REACTIONS/FUSION REACTIONS
Single particle nature of the yrast line at high angular momentum in ^{158}Dy, 5:24923
SULFUR COMPOUNDS/REMOVAL
Coal-based ammonia plants: preliminary operating experience of coal gasification at Talcher and Ramagundam fertilizer plants of The Fertilizer Corporation of India, 5:23788
Final sulfur removal in ammonia from coal plants, 5:23416
SULFUR DIOXIDE/ABSORPTION
Method for recovering concentrated sulphur dioxide from waste gases containing sulphur dioxide (Patent), 5:23513
SULFUR DIOXIDE/AERIAL MONITORING
Estimated dry deposition velocities of sulfur over the eastern United States and surrounding regions, 5:24627
SULFUR DIOXIDE/AIR POLLUTION CONTROL
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 1. Task I report: literature review, basis for selecting calcium-based sorbents. Final report, 5:24032 (EPRI-FP—1307(Vol.1))
Criteria for the selection of SO_2 sorbents for atmospheric pressure fluidized-bed combustors. Volume 2. Tasks II and III report: experimental work, sorbent selection technique. Final report, November 1, 1976-July 31, 1977, 5:24033 (EPRI-FP—1307(Vol.2))
Effectiveness and cost of air pollution control for coal-fired electric power plants in the west, 5:24037 (PB—300515)
SULFUR DIOXIDE/ATMOSPHERIC CHEMISTRY
Impact of gaseous sulfur and aerosols produced by power plants on the CCN budget. Progress report, September 1, 1978-August 31, 1979, 5:24590 (COO—4965-1)

SULFUR DIOXIDE/BIOLOGICAL EFFECTS
Remote sensing of sulfur dioxide effects on vegetation - photometric analysis of aerial photographs, 5:24767 (PB—300460)
SULFUR DIOXIDE/ENVIRONMENTAL EFFECTS
Impact of gaseous sulfur and aerosols produced by power plants on the CCN budget. Progress report, September 1, 1978-August 31, 1979, 5:24590 (COO—4965-1)
SULFUR DIOXIDE/FORECASTING
The calculation of long period mean pollutant concentrations in an urban atmosphere. Part II. Simulation of annual sulfur dioxide concentrations in Mexico City, 5:24605 (PB—299726)
SULFUR DIOXIDE/OXIDATION
SO_2 oxidation rate on well-characterized surfaces, a laboratory study. Final report 15 May 1978-14 May 1979, 5:24619 (PB—301288)
SULFUR HYDRIDES
See HYDROGEN SULFIDES
SULFUR OXIDES/AIR POLLUTION ABATEMENT
Performance of a diesel engine operating on raw coal-diesel fuel and solvent refined coal-diesel fuel slurries. Final report, 5:24335 (CONS—3288-T6)
SULFURIC ACID/CORROSIVE EFFECTS
Silicon-nitride and metal composite (Patent), 5:24427
SUPERCONDUCTING CABLES/DESIGN
dc Superconducting Power Transmission Line project at LASL: US DOE Division of Electric Energy Systems. Progress report No. 24, November 1, 1972-September 30, 1979. Final report, 5:24041 (LA—8323-PR)
SUPERCONDUCTING CABLES/MAGNETIZATION
Paramagnetic properties of mixed-matrix NbTi conductors, 5:24513 (CONF-791102—169)
SUPERCONDUCTING CABLES/PERFORMANCE TESTING
dc Superconducting Power Transmission Line project at LASL: US DOE Division of Electric Energy Systems. Progress report No. 24, November 1, 1972-September 30, 1979. Final report, 5:24041 (LA—8323-PR)
SUPERCONDUCTING CABLES/RESEARCH PROGRAMS
dc Superconducting Power Transmission Line project at LASL: US DOE Division of Electric Energy Systems. Progress report No. 24, November 1, 1972-September 30, 1979. Final report, 5:24041 (LA—8323-PR)
LASL Nb_3Ge conductor development. Fourteenth quarterly progress report, October 1-December 31, 1979, 5:24969 (LA—8320-PR)
SUPERCONDUCTING COMPOSITES/MATHEMATICAL MODELS
Prediction of the stress state in Nb_3Sn superconducting composites, 5:24397
SUPERCONDUCTING COMPOSITES/STRESSES
Prediction of the stress state in Nb_3Sn superconducting composites, 5:24397
SUPERCONDUCTING MAGNETS
See also MAGNETIC ENERGY STORAGE
SUPERCONDUCTING MAGNETS/DESIGN
Superconducting magnet fabrication development, 5:24224 (FE—2215-13(Vol.1))
SUPERCONDUCTING WIRES/MAGNETIC SHIELDING
General critical state model in two dimensions and zero applied field: A uniqueness theorem and some consequences, 5:24968
SUPERCONDUCTORS
See also TYPE-II SUPERCONDUCTORS
SUPERCONDUCTORS/ELECTRON MICROSCOPY
Application of low-temperature scanning electron microscopy to superconductors, 5:24514
SUPERCONDUCTORS/ELECTRON SCANNING
Application of low-temperature scanning electron microscopy to superconductors, 5:24514
SUPERCONDUCTORS/FABRICATION
Development of A-15 (V_3Ga) superconducting material through controlled precipitation, 5:24515
SUPERHEAVY ELEMENTS
See TRANS 104 ELEMENTS
SUPEROXIDE RADICALS/RADIOSENSITIVITY EFFECTS
Does oxygen enhance the radiation: induced inactivation of penicillinase. Progress report, December 1, 1979-November 30, 1980, 5:24734 (DOE/EV/03221—62)
SURFACE CLEANING/ULTRASONIC WAVES
Evaluation of ultrasonic cleaning systems, 5:24505 (GEPP-OP—501)
SURFACE COATING
process for coating a substrate with a radiation and moisture curable coating composition (Patent), 5:24503
SURFACE COATING/REVIEWS
Advanced electron beam techniques for metallic and ceramic protective coating systems, 5:24293 (LBL—10520)
SURFACE COATING/WEAR
Dispersion of life of bonded MoS2 solid lubricant coatings, 5:24391
SURFACE CONTAMINATION/CONTROL
Need for a contamination control textbook, 5:24517 (UCRL—84327)
SURFACE MINING
See also COAL MINING
OIL SHALE MINING
SURFACE MINING/BACKFILLING
Disposal of high alkaline fly ash sludge in a decoaled mine seam, 5:23505 (METC/SP—79/10(Pt.2))
SURFACE MINING/ENVIRONMENTAL EFFECTS
Evaluation of the environmental effects of western surface coal mining. Volume II. Mine inventory. Final report, 5:23529 (PB—301249)
Strip coal mining and mined-land reclamation in the hydrologic system, southeastern Montana. Project completion report, 5:23530 (PB—301253)
SURFACE MINING/ENVIRONMENTAL IMPACTS
Effects of contour coal strip mining on stormwater runoff and quality, 5:23518 (ORO—4946-T1)
SURFACE MINING/LAND RECLAMATION
Application of fly ash and other wastes to mine soils as an aid in revegetation, 5:23517 (METC/SP—79/10(Pt.2))
Hillman State Park: final assessment of fly ash as a soil modifier for acidic strip mine spoil, 5:23516 (METC/SP—79/10(Pt.2))
Strip coal mining and mined-land reclamation in the hydrologic system, southeastern Montana. Project completion report, 5:23530 (PB—301253)
SURFACE MINING/RUNOFF
Effects of contour coal strip mining on stormwater runoff and quality, 5:23518 (ORO—4946-T1)
SURFACE MINING ACTS/LAND RECLAMATION
Mining reclamation laws, 5:23571
SURFACE TREATMENTS/OXIDATION
Effect of container preparation on the growth of protium and methane impurities into tritium gas, 5:25095
SURFACE-ACTIVE AGENTS
See SURFACTANTS
SURFACES
See also SPECTRALLY SELECTIVE SURFACES
SURFACES/CRYSTAL STRUCTURE
1979 LEED analysis of Cu(100), 5:24408
SURFACES/ELECTRON DIFFRACTION
1979 LEED analysis of Cu(100), 5:24408
SURFACES/PHYSICAL PROPERTIES
Aims and recent accomplishments of surface theory, 5:24966
SURFACTANTS/ENZYME INHIBITORS
Effect of the composition of sodium dodecyl sulfate preparations on the renaturation of enzymes after polyacrylamide gel electrophoresis, 5:24675
SURFACTANTS/PRECIPITATION
Precipitation of petroleum sulfonates by magnesium ions, 5:23578 (DOE/BETC/RI—80/3)
SURVEY MONITORS/CALIBRATION
Studies of long-term ecological effects of exposure to uranium V, 5:24647 (LA—8221)
SUSPENSIONS (FUEL)
See FUEL SLURRIES
SWEDEN/WAVE POWER
Wave measuring project for wave energy prospecting purpose, 5:24001 (SMHI-HBF-PM—229)
SWIMMING POOLS/SOLAR WATER HEATING
Evaluation of solar pond performance, 5:23953 (MLM—2702(OP))
SWITCHES/DESIGN
Optically coupled microwave switch, 5:24570 (SAND—80-0029C)
SWITCHES/PERFORMANCE
Optically coupled microwave switch, 5:24570 (SAND—80-0029C)
SYNCHROTRON RADIATION/REVIEWS
Characteristics of synchrotron radiation and of its sources, 5:24557 (BNL—27678)
SYNCHROTRONS
See also NSLS
SERPUKHOV SYNCHROTRON
SYNCHROTRONS/BEAM OPTICS
Characteristics of synchrotron radiation and of its sources, 5:24557 (BNL—27678)
SYNCHROTRONS/REVIEWS
Characteristics of synchrotron radiation and of its sources, 5:24557 (BNL—27678)
SYNCHROTRONS/SYNCHROTRON RADIATION
Characteristics of synchrotron radiation and of its sources, 5:24557 (BNL—27678)
SYNROC PROCESS
High-level waste program progress report, January 1, 1980-March 31, 1980, 5:23722 (ORNL/TM—7371)
SYNTHESIS GAS/CHEMICAL COMPOSITION
Final sulfur removal in ammonia from coal plants, 5:23416
SYNTHESIS GAS/PURIFICATION
Ammonia from coal, 5:23778

Final suifur removal in ammonia from coal plants, 5:23416
Lurgi pressure gasification and its application for ammonia manufacture, 5:23782
Operating experience on a 1,000-ton/day ammonia plant at Modderfontein, 5:23790
SYNTHESIS GAS/SYNTHESIS
Partial oxidation process (Patent), 5:23772
SYNTHETIC FUELS
See also ALCOHOL FUELS
HYDROGEN FUELS
SYNTHETIC PETROLEUM
SYNTHETIC FUELS/MUTAGEN SCREENING
Mutagenicity testing of aqueous materials from alternate fuel production, 5:24765 (CONF-790663—3)
SYNTHETIC FUELS/PRODUCTION
Tritium management in fusion synfuel designs, 5:23765 (UCRL—83928)
SYNTHETIC PETROLEUM/MUTAGEN SCREENING
Mutagenicity testing of aqueous materials from alternate fuel production, 5:24765 (CONF-790663—3)

T

TANKS/CONSTRUCTION
Liquefied natural gas tank construction (Patent), 5:23614
TANTALUM/ELECTRONIC STRUCTURE
Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
TANTALUM/ENERGY-LEVEL TRANSITIONS
Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
TANTALUM/PION MINUS REACTIONS
Products of stopped-pion interactions with Cu and Ta, 5:24914
TANTALUM/REFLECTIVITY
Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
TANTALUM/SURFACE COATING
Method for making hot-pressed fiber-reinforced carbide-graphite composite (Patent), 5:24455
Thermodynamics of the tantalum-carbon-chlorine-hydrogen system applied to the CVD of carbide/carbon composite materials, 5:24395 (LA-UR—80-1252)
TANTALUM/THERMODYNAMIC PROPERTIES
Thermodynamics of the tantalum-carbon-chlorine-hydrogen system applied to the CVD of carbide/carbon composite materials, 5:24395 (LA-UR—80-1252)
TANTALUM 181 TARGET/NEON 20 REACTIONS
Target residues from the reaction of 8 GeV ^{20}Ne with ^{181}Ta and ^{197}Au, 5:24926
TANTALUM CARBIDES/FABRICATION
Method for making hot-pressed fiber-reinforced carbide-graphite composite (Patent), 5:24455
TANTALUM CARBIDES/HOT PRESSING
Method for making hot-pressed fiber-reinforced carbide-graphite composite (Patent), 5:24455
TANTALUM CARBIDES/SURFACE COATING
Thermodynamics of the tantalum-carbon-chlorine-hydrogen system applied to the CVD of carbide/carbon composite materials, 5:24395 (LA-UR—80-1252)
TANTALUM CARBIDES/THERMODYNAMIC PROPERTIES
Thermodynamics of the tantalum-carbon-chlorine-hydrogen system applied to the CVD of carbide/carbon composite materials, 5:24395 (LA-UR—80-1252)
TANTALUM HYDRIDES/ELECTRONIC STRUCTURE
Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
TANTALUM HYDRIDES/ENERGY-LEVEL TRANSITIONS
Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
TANTALUM HYDRIDES/INTERSTITIALS
Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
TANTALUM HYDRIDES/REFLECTIVITY
Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
TAR SANDS
See OIL SANDS
TARGETS
See also ELECTRON BEAM TARGETS
LASER TARGETS
TARGETS/ENERGY TRANSFER
Coupling of electron-beam energy to an expanding thick-shelled target, 5:25065
Space-time energy concentration and the design of DT fusion micro-explosions, 5:25077 (UCRL—81919)
TARGETS/FABRICATION
Characterization techniques for high quality ICF targets, 5:23760 (UCRL—82530)
TARGETS/SPECTROSCOPY
Soft x-ray vacuum ultraviolet spectroscopy of thin targets heated by enhanced electron energy deposition, 5:24481
TARGETS/TUBES
High-temperature, high-pressure bonding of nested tubular metallic components (Patent), 5:24568
TAU LEPTONS
See TAU PARTICLES
TAU PARTICLES/DECAY
Recent results from the Mark II detector at SPEAR, 5:24837
TAU PARTICLES/WEAK HADRONIC DECAY
Decays of the heavy lepton, tau (1785), 5:24846 (LBL—10801)
TAUONS
See TAU PARTICLES
TECHNOLOGY ASSESSMENT/ENERGY ANALYSIS
Framework for energy policy and technology assessment in developing countries: a case study of Peru, 5:24200 (BNL—27613)
TECHNOLOGY UTILIZATION/DECISION MAKING
Overview report: experiment in computer applications for regulatory agencies. Final report, 5:24213 (PB—300770)
TECTONICS/GROUND UPLIFT
New evidence for tectonic uplift in the Diablo Plateau region, West Texas, 5:24786
TELEVISION CAMERAS/ELECTRON MULTIPLIER DETECTORS
Video recording of low intensity CEMA images, 5:24540
TELEVISION CAMERAS/RADIATION DETECTORS
Video recording of low intensity CEMA images, 5:24540
TELLURIUM 122 TARGET/HELIUM 3 REACTIONS
(^{3}He, n) reaction on tellurium isotopes (25.4 MeV, angular distributions, zero-range DWBA, pairing model), 5:24918
TELLURIUM 124 TARGET/HELIUM 3 REACTIONS
(^{3}He, n) reaction on tellurium isotopes (25.4 MeV, angular distributions, zero-range DWBA, pairing model), 5:24918
TELLURIUM 125 TARGET/HELIUM 3 REACTIONS
(^{3}He, n) reaction on tellurium isotopes (25.4 MeV, angular distributions, zero-range DWBA, pairing model), 5:24918
TELLURIUM 126 TARGET/HELIUM 3 REACTIONS
(^{3}He, n) reaction on tellurium isotopes (25.4 MeV, angular distributions, zero-range DWBA, pairing model), 5:24918
TELLURIUM 126 TARGET/TRITON REACTIONS
Search for nuclear structure dependence of analyzing powers for the (t,p) reaction in medium mass nuclei, 5:24917
TELLURIUM 128/ENERGY LEVELS
Search for nuclear structure dependence of analyzing powers for the (t,p) reaction in medium mass nuclei, 5:24917
TELLURIUM 128 TARGET/HELIUM 3 REACTIONS
(^{3}He, n) reaction on tellurium isotopes (25.4 MeV, angular distributions, zero-range DWBA, pairing model), 5:24918
TELLURIUM 130 TARGET/HELIUM 3 REACTIONS
(^{3}He, n) reaction on tellurium isotopes (25.4 MeV, angular distributions, zero-range DWBA, pairing model), 5:24918
TEMPERATURE MEASUREMENT/INDICATORS
Chemical temperature indicators for geothermal applications. Final report, 5:23996 (DGE—4008-F)
TEMPERATURE MEASUREMENT/MEASURING INSTRUMENTS
Bell Canyon Test (BCT) instrumentation development, 5:24571 (SAND—80-0408C)
TENNESSEE VALLEY AUTHORITY/FERTILIZERS
Ammonia from coal, 5:23778
TERBIUM 149/ALPHA DECAY
Decay of deformed and superdeformed nuclei formed in heavy ion reactions, 5:24910
TERMINAL FACILITIES
See also LIQUEFIED NATURAL GAS
TERMINAL FACILITIES/MATERIALS HANDLING
Great Lakes: a valuable link in the intermodal movement of western coal (Involving transshipment and storage), 5:23554
TEST FACILITIES/DEACTIVATION
Coal liquefaction test center. Quarterly report, April 1, 1979-June 30, 1979, 5:23441 (FE—1517-90)
Coal liquefaction test center. Quarterly report, July 1, 1979-September 30, 1979, 5:23442 (FE—1517-91)
Coal liquefaction test center. Annual report, January 1, 1979-September 30, 1979, 5:23443 (FE—1517-92)

TEST FACILITIES/DESIGN
Design and construction of the Tritium Systems Test Assembly, 5:25067 (LA-UR—80-1203)
Thermal Energy Storage Test Facility, 5:24249 (CONF-791242—2)
Tritium Systems Test Assembly: objectives and design, 5:25066 (LA-UR—79-2971)
TEST FACILITIES/MEASURING INSTRUMENTS
Measuring and modeling solids movement in a large, cold fluidized bed test facility. First quarterly report, 1 October, 31 December 1979 (More than 100 references), 5:23560 (DOE/ET/13152—1)
TEST FACILITIES/OPERATION
Thermal Energy Storage Test Facility, 5:24249 (CONF-791242—2)
TEST FACILITIES/PRESERVATION
Coal liquefaction test center. Quarterly report, April 1, 1979-June 30, 1979, 5:23441 (FE—1517-90)
Coal liquefaction test center. Quarterly report, July 1, 1979-September 30, 1979, 5:23442 (FE—1517-91)
Coal liquefaction test center. Annual report, January 1, 1979-September 30, 1979, 5:23443 (FE—1517-92)
TEST FACILITIES/SAFETY
Preliminary analysis of the safety and environmental impact of the Tritium Systems Test Assembly, 5:25068 (LA-UR—80-1249)
TEST FACILITIES/TRITIUM RECOVERY
Fuel cleanup system for the tritium systems test assembly: design and experiments, 5:25069 (LA-UR—80-1273)
TETRACYCLINES/BIOLOGICAL EFFECTS
Effect of tetracycline hydrochloride treatment on the critical thermal maximum of common shiners, 5:24773
TEXACO GASIFICATION PROCESS/CHEMICAL REACTIONS
Current status of the Texaco coal gasification process, 5:23785
TEXACO GASIFICATION PROCESS/DEMONSTRATION PLANTS
Status of the Texaco coal dust gasification operating in the Ruhrchemie/Ruhrkohle demonstration plant at Oberhausen-Holten, 5:23437
TVA project for production of ammonia from coal, 5:23792
TEXACO GASIFICATION PROCESS/FLOWSHEETS
Current status of the Texaco coal gasification process, 5:23785
TEXACO GASIFICATION PROCESS/SYNTHESIS GAS
Final sulfur removal in ammonia from coal plants, 5:23416
TEXAS/AEROSOL MONITORING
HAOS quality assurance final report: non-criteria pollutants. Volume II. Final report, 5:24601 (PB—299640)
TEXAS/AIR POLLUTION
Airborne aeroallergen measurements in Houston, Texas. Final report, 5:24602 (PB—299643)
Haos quality assurance final report: criteria pollutants. Volume I. Final report, 5:24600 (PB—299639)
HAOS quality assurance final report: non-criteria pollutants. Volume II. Final report, 5:24601 (PB—299640)
TEXAS/ELECTRIC UTILITIES
Analysis of environmental factors affecting technology deployment: a case study, 5:24027 (DOE/RA/10001—T1)
TEXAS/GEOCHEMICAL SURVEYS
Investigations of the uranium potential along the Proterozoic unconformity in the Van Horn Areas, Texas. Final report, 5:23688 (GJBX—97(80))
TEXAS/SEISMICITY
Seismicity of the salt areas of Texas, Louisiana, Oklahoma and Kansas, 5:24785 (UCRL—15221)
TEXAS/TECTONICS
New evidence for tectonic uplift in the Diablo Plateau region, West Texas, 5:24786
TEXAS EXPERIMENTAL TOKAMAK
See TEXT DEVICES
TEXT DEVICES/DESIGN
Contacts for pulsed high current: design and test, 5:25053
TEXT DEVICES/ELECTRIC GROUNDS
Safety grounding switches in large experiments; general considerations and the TEXT application, 5:25061
TEXTILE INDUSTRY/ENERGY CONSERVATION
Application of foams to the processing of fabrics. Phase-III. Technical progress report, September 1, 1979-February 29, 1980, 5:24299 (DOE/CS/40056—T1)
Energy conservation in the textile industry. Phase II. Final report, June 1977-August 1978, 5:24300 (ORO—5099-T2)
TEXTILE INDUSTRY/ENERGY CONSUMPTION
Energy conservation in the textile industry. Phase II. Final report, June 1977-August 1978, 5:24300 (ORO—5099-T2)
TEXTILE INDUSTRY/SOLAR PROCESS HEAT
Operational experience of the LaFrance, South Carolina solar process hot water system, 5:23920 (SERI/TP—333-429)
Textile drying at WestPoint Pepperell using solar process steam, 5:23925 (SERI/TP—333-429)
TEXTILES/PROCESSING
Application of foams to the processing of fabrics. Phase-III. Technical progress report, September 1, 1979-February 29, 1980, 5:24299 (DOE/CS/40056—T1)
TEXTILES/SOLAR DRYING
Textile drying at WestPoint Pepperell using solar process steam, 5:23925 (SERI/TP—333-429)
TFTR REACTORS/ELECTRON TUBES
High power very long pulse testing of a 200 kv. tetrode regulation tube, 5:25055
TFTR REACTORS/FATIGUE
Transient getter scheme for the Tokamak Fusion Test Reactor, 5:25099
TFTR REACTORS/GETTERING
Transient getter scheme for the Tokamak Fusion Test Reactor, 5:25099
TFTR REACTORS/SEALS
Development of bakeable seals for large noncircular ports on the Tokamak Fusion Test Reactor, 5:24534
THALLIUM 203 TARGET/MUON REACTIONS
Nuclear disintegration of some complex nuclei by 60-MeV muons, 5:24899
THALLIUM SELENIDES/PHONONS
Temperature dependence of the phonon dispersion in Tl_3PSe_4, 5:24466
THERMAL BATTERIES/ANODES
Characterization of aged unactivated thermal battery components, 5:24126
Lithium-boron alloy: a new battery anode material, 5:24161
THERMAL BATTERIES/FEASIBILITY STUDIES
New electrochemical cells based upon molten nitrate salts, 5:24109
THERMAL BATTERIES/PERFORMANCE
Lithium-boron alloy: a new battery anode material, 5:24161
Low temperature, long-life, pelletized $LiAl/CuCl_2$ single cell for thermal battery applications, 5:24108
Low temperature thermal battery: the $LiAl/NaAlCl_4/MoCl_5$ system, 5:24128
Studies on some non-standard systems for thermal battery applications, 5:24107
Thermal battery improvements (Li-Al/FeS_2), 5:24127
THERMAL BATTERIES/TESTING
Characterization of aged unactivated thermal battery components, 5:24126
THERMAL ENERGY STORAGE EQUIPMENT/FEASIBILITY STUDIES
Evaluation of thermal energy storage for a large urban hot water district heating system in the United States, 5:24101 (CONF-7910152—1)
THERMAL ENERGY STORAGE EQUIPMENT/FLUIDIZED BED
Convective instability of a volumetrically heated porous bed, 5:23978
THERMAL ENERGY STORAGE EQUIPMENT/LATENT HEAT STORAGE
Analysis of energy storage by phase change with an array of cylindrical tubes, 5:23976
THERMAL ENERGY STORAGE EQUIPMENT/PERFORMANCE
Analysis of energy storage by phase change with an array of cylindrical tubes, 5:23976
Evaluation of thermal energy storage for a large urban hot water district heating system in the United States, 5:24101 (CONF-7910152—1)
THERMAL ENERGY STORAGE EQUIPMENT/PERFORMANCE TESTING
Heat transfer and calorimetric studies of a direct contact-latent heat energy storage system, 5:23977
Test experience at the DOE/Sandia Midtemperature Solar Systems Test Facility, 5:23956 (SERI/TP—333-429)
Thermal Energy Storage Test Facility, 5:24249 (CONF-791242—2)
THERMAL ENERGY STORAGE EQUIPMENT/TEST FACILITIES
Thermal Energy Storage Test Facility, 5:24249 (CONF-791242—2)
THERMAL INSULATION/INSTALLATION
Field study of moisture damage in walls insulated without a vapor barrier. Final report for the Oregon Department of Energy, 5:24245 (ORNL/Sub—78/97726/1)
THERMAL INSULATION/PERFORMANCE TESTING
Field study of moisture damage in walls insulated without a vapor barrier. Final report for the Oregon Department of Energy, 5:24245 (ORNL/Sub—78/97726/1)
THERMAL POWER PLANTS
See also COMBINED-CYCLE POWER PLANTS
FOSSIL-FUEL POWER PLANTS
GEOTHERMAL POWER PLANTS
NUCLEAR POWER PLANTS

THERMAL POWER PLANTS/COOLING SYSTEMS
Summary of equilibrium and process model data acquisition: treatment of recirculated cooling water, Resource Document 1. Interim report, 5:24007 (EPRI-FP—1251)
THERMAL POWER PLANTS/FUEL SLURRIES
Theoretical studies on heterogeneous combustion. Progress report, March 1, 1979-February 29, 1980, 5:24022 (COO—4433-3)
THERMAL POWER PLANTS/RETROFITTING
District heating and cooling system for communities through power plant retrofit and distribution network. Final report, Phase I, 5:24323 (COO—4980-1)
District heating and cooling through power plant retrofit and distribution network. Final report. Phase I, executive summary, 5:24324 (COO—4980-1(Exec.Summ.))
District heating and cooling systems for communities through power plant retrofit and distribution network. Final report. Volume II. Appendices, 5:24325 (COO—4975-1(Vol.2)(App.))
THERMAL POWER PLANTS/WATER REQUIREMENTS
Water management model for Front Range River Basins, 5:24008 (PB—299950)
THERMAL SPRINGS/GEOCHEMICAL SURVEYS
Geothermal investigation of spring and well waters of the Los Alamos Region, New Mexico, 5:23986 (LA—8326-MS)
THERMAL STORAGE
See HEAT STORAGE
THERMIONIC CONVERTERS/DESIGN
Solar-powered thermionic-photoelectric generator using laser, 5:24231
THERMIONIC EMISSION/CURRENT DENSITY
Obtaining numerical values for the elliptic emission functions used in calculating electron emission from surfaces, 5:24957
THERMITE PROCESS/IGNITION
Role of surface chemistry in the ignition of pyrotechnic materials, 5:24580 (MLM—2708(OP))
THERMOCHEMICAL PROCESSES/INFORMATION SYSTEMS
Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model). Quarterly technical progress report, Februray 1, 1980-April 30, 1980, 5:23835 (DOE/ET/20611—12)
THERMOELECTRIC GENERATORS/EQUIPMENT PROTECTION DEVICES
Thermoelectric generator overload protective device using hysterisis control (Patent), 5:24230
THERMOELECTRIC GENERATORS/SPECIFICATIONS
Recent terrestrial and undersea applications of radioisotope thermoelectric generators, 5:23767
THERMOELECTRIC GENERATORS/USES
Recent terrestrial and undersea applications of radioisotope thermoelectric generators, 5:23767
THERMONUCLEAR FUELS/FABRICATION
Characterization techniques for high quality ICF targets, 5:23760 (UCRL—82530)
THERMONUCLEAR POWER PLANTS/ENVIRONMENTAL IMPACTS
Climate and energy: a comparative assessment of the Satellite Power System (SPS) and alternative energy technologies, 5:23798 (DOE/ER—0050)
THERMONUCLEAR POWER PLANTS/HEALTH HAZARDS
Health and safety. Preliminary comparative assessment of the satellite power system (SPS) and other energy alternatives, 5:23847 (DOE/ER—0053)
THERMONUCLEAR REACTOR MATERIALS/RESEARCH PROGRAMS
Damage analysis and fundamental studies. Quarterly progress report, October-December 1979, 5:25089 (DOE/ET—0065/8)
THERMONUCLEAR REACTOR WALLS/ADSORPTION
X-ray photoelectron spectroscopy (XPS) studies of oxygen and carbon bonding to tokamak walls, 5:25098
THERMONUCLEAR REACTORS
(For use in cases where certain aspects of either hypothetical or real thermonuclear reactors are discussed.)
See also E-BEAM TYPE REACTORS
FIELD-REVERSED MIRROR REACTORS
I-BEAM TYPE REACTORS
LASER FUSION REACTORS
MAGNETIC MIRROR TYPE REACTORS
TFTR REACTORS
THERMONUCLEAR REACTOR WALLS
TMR REACTORS
TOKAMAK TYPE REACTORS
THERMONUCLEAR REACTORS/CYCLOTRON RADIATION
Cyclotron radiation by a multi-group method, 5:25011 (COO—2218-160)
THERMONUCLEAR REACTORS/FUEL CYCLE
Tritium management in fusion synfuel designs, 5:23765 (UCRL—83928)
THERMONUCLEAR REACTORS/RADIOACTIVE WASTE DISPOSAL
Reduction in the toxicity of fission product wastes through transmutation with deuterium-tritium fusion neutrons, 5:25071
THERMONUCLEAR REACTORS/SHIELDING
Integral experiments for fusion reactor design: analysis, 5:25084 (CONF-791058—74)
THERMONUCLEAR REACTORS/SITE SELECTION
Evaluation of the impact of a committed site on fusion reactor development, 5:25044 (CONF-791102—163)
THERMONUCLEAR REACTORS/TARGETS
Fusion target evaluation by buoyancy analysis, 5:23762
THETA PINCH/IMPURITIES
Measurement of effective ionization and recombination rate coefficients for intermediate iron ions in a laser generated theta-pinch heated plasma, 5:25008
THETA PINCH/SHOCK HEATING
Laser scattering measurements of plasma turbulence in a fast theta pinch, 5:25009
THETA PINCH/TURBULENCE
Laser scattering measurements of plasma turbulence in a fast theta pinch, 5:25009
THORIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
THORIUM/GAMMA SPECTROSCOPY
Investigations of the uranium potential along the Proterozoic unconformity in the Van Horn Areas, Texas. Final report, 5:23688 (GJBX—97(80))
THORIUM/X-RAY FLUORESCENCE ANALYSIS
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
THORIUM 230/ENERGY LEVELS
Levels of ^{230}Ac and ^{230}Th populated by decay of ^{230}Ra and ^{230}Ac, 5:24935
THORIUM 230/ENERGY-LEVEL TRANSITIONS
Levels of ^{230}Ac and ^{230}Th populated by decay of ^{230}Ra and ^{230}Ac, 5:24935
THORIUM 232 TARGET/NEUTRON REACTIONS
Levels of ^{230}Ac and ^{230}Th populated by decay of ^{230}Ra and ^{230}Ac, 5:24935
THORIUM CARBIDES/REPROCESSING
Reprocessing nuclear fuels of the future: a radiological assessment of advanced (Th,U) carbide fuel, 5:23704
THORIUM CYCLE
Nuclear technology developments affecting uranium needs, 5:23672
THORIUM ORES/EXPLORATION
Investigations of the uranium potential along the Proterozoic unconformity in the Van Horn Areas, Texas. Final report, 5:23688 (GJBX—97(80))
THORON
See RADON 220
THREE MILE ISLAND-2 REACTOR/AFTER-HEAT
TMI-2 decay power: LASL fission-product and actinide decay power calculations for the President's commission on the accident at Three Mile Island, 5:24047 (LA—8041-MS(Rev))
THREE MILE ISLAND-2 REACTOR/FUEL ELEMENT FAILURE
Fuel damage estimates for the TMI-2 reactor, 5:24094 (LA-UR—80-1069)
THREE MILE ISLAND-2 REACTOR/RADIOACTIVE WASTE PROCESSING
Plenary lecture - a special radioelement problem: ORNL assistance to Three Mile Island in handling contaminated air and water, 5:24083 (CONF-791049—26)
THREE MILE ISLAND-2 REACTOR/REACTOR ACCIDENTS
Fuel damage estimates for the TMI-2 reactor, 5:24094 (LA-UR—80-1069)
Plenary lecture - a special radioelement problem: ORNL assistance to Three Mile Island in handling contaminated air and water, 5:24083 (CONF-791049—26)
THULIUM 169 TARGET/CHLORINE 35 REACTIONS
New isotope ^{169}Rn and evidence for an isomeric state ^{169}Rn/sup m/, 5:24929
TIN/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
TIN/PERMITTIVITY
Optical properties of liquid tin between 0.62 and 3.7 eV, 5:24398
TIN/PHOTON TRANSPORT
Z dependence of the laser-intensity threshold for inhibited electron thermal conduction, 5:24951

TIN/REFLECTIVITY
Optical properties of liquid tin between 0.62 and 3.7 eV, 5:24398
TIN 116/NUCLEAR DEFORMATION
Isovector deformation parameters and core polarization, 5:24915
TIN 118/NUCLEAR DEFORMATION
Isovector deformation parameters and core polarization, 5:24915
TIN 120/NUCLEAR DEFORMATION
Isovector deformation parameters and core polarization, 5:24915
TIN 122/NUCLEAR DEFORMATION
Isovector deformation parameters and core polarization, 5:24915
TIN 122 TARGET/SULFUR 34 REACTIONS
Single particle nature of the yrast line at high angular momentum in ^{152}Dy, 5:24923
TIN 124 TARGET/SULFUR 32 REACTIONS
Single particle nature of the yrast line at high angular momentum in ^{152}Dy, 5:24923
TIN 125/NUCLEAR DEFORMATION
Isovector deformation parameters and core polarization, 5:24915
TIN ALLOYS/CRITICAL CURRENT
Prediction of the stress state in Nb_3Sn superconducting composites, 5:24397
TIN ALLOYS/STRAINS
Effect of strain upon the scaling law for flux pinning in bronze process Nb_3Sn, 5:24404
TIN ALLOYS/SUPERCONDUCTIVITY
Effect of strain upon the scaling law for flux pinning in bronze process Nb_3Sn, 5:24404
TIN OXIDES/SPUTTERING
Sputtered indium-tin oxide/cadmium telluride junctions and cadmium telluride surfaces, 5:23824
Sputtered oxide/indium phosphide junctions and indium phosphide surfaces, 5:24294
TIRES/WEAR
Evaluation of particulate emission factors for vehicle tire wear. Final report, 5:24609 (PB—300443)
TISSUE DISTRIBUTION/TIME DEPENDENCE
Curium-243,4 in the tissues of the adult baboon (Time-dependent effects of DTPA administration on excretion), 5:24757 (COO—3382-18)
TITANIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
TITANIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
TITANIUM/CATALYTIC EFFECTS
Catalyst for synthesis of methanol (Patent), 5:23774
TITANIUM/EMISSION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
TITANIUM/EXPLOSION WELDING
Viscosity of metals in explosive welding, 5:24371 (UCRL-Trans—11542)
TITANIUM/IGNITION
Role of surface chemistry in the ignition of pyrotechnic materials, 5:24580 (MLM—2708(OP))
TITANIUM/PHOTON TRANSPORT
Z dependence of the laser-intensity threshold for inhibited electron thermal conduction, 5:24951
TITANIUM/PHYSICAL RADIATION EFFECTS
Experimental observations of effects of inert gas on cavity formation during irradiation, 5:24423 (ORNL/TM—7193)
TITANIUM/SORPTIVE PROPERTIES
Methane outgassing from a Ti sublimation pump, 5:24558
TITANIUM 46 TARGET/MUON REACTIONS
Nuclear disintegration of some complex nuclei by 60-MeV muons, 5:24899
TITANIUM 48 TARGET/MUON REACTIONS
Nuclear disintegration of some complex nuclei by 60-MeV muons, 5:24899
TITANIUM ALLOYS/CORROSION
Corrosion behavior of lean uranium-titanium alloys, 5:24414 (SAND—80-8215)
TITANIUM ALLOYS/CRACKS
Hydrogen absorption in metals: a field ion microscopy study. Progress report, June 1, 1979-May 31, 1980, 5:24386 (DOE/ER/10430—1)
TITANIUM ALLOYS/FABRICATION
Alloys for a liquid metal fast breeder reactor (Patent), 5:24372
TITANIUM ALLOYS/MAGNETIZATION
Paramagnetic properties of mixed-matrix NbTi conductors, 5:24513 (CONF-791102—169)
TITANIUM ALLOYS/OXIDATION
Corrosion behavior of lean uranium-titanium alloys, 5:24414 (SAND—80-8215)
TITANIUM ALLOYS/SAMPLE PREPARATION
Hydrogen absorption in metals: a field ion microscopy study. Progress report, June 1, 1979-May 31, 1980, 5:24386 (DOE/ER/10430—1)
TITANIUM BORIDES/PERFORMANCE TESTING
Testing of low Z coated limiters in tokamak fusion devices, 5:25092 (SAND—79-2105C)
TITANIUM BORIDES/PHYSICAL RADIATION EFFECTS
Development and laboratory testing of low Z refractory coatings for fusion reactor limiters, 5:25093 (SAND—79-2409C)
TITANIUM CARBIDES/PERFORMANCE TESTING
Testing of low Z coated limiters in tokamak fusion devices, 5:25092 (SAND—79-2105C)
TITANIUM CARBIDES/PHYSICAL RADIATION EFFECTS
Development and laboratory testing of low Z refractory coatings for fusion reactor limiters, 5:25093 (SAND—79-2409C)
TITANIUM HYDRIDES/FABRICATION
Shock compaction of a porous pyrotechnic material, 5:24430 (SAND—80-0427C)
TITANIUM HYDRIDES/IGNITION
Thermal and electrostatic initiation of TiH/sub x/ based pyrotechnics, 5:24582 (MLM—2710(OP))
TITANIUM NITRIDES/PHYSICAL RADIATION EFFECTS
Effect of neutron irradiation upon the superconducting critical temperature of some transition-metal carbides, nitrides, and carbonitrides, 5:24434
TITANIUM NITRIDES/SUPERCONDUCTIVITY
Effect of neutron irradiation upon the superconducting critical temperature of some transition-metal carbides, nitrides, and carbonitrides, 5:24434
TITANIUM OXIDES/EMISSION SPECTRA
Titanium oxide Phi system, 5:24816
TITANIUM OXIDES/NEAR INFRARED RADIATION
Titanium oxide Phi system, 5:24816
TITANIUM OXIDES/PRODUCTION
Glass-ceramics for lightning arrestor connector seals, 5:24429 (SAND—80-0215)
TMR REACTORS/ECONOMICS
Tandem mirror fusion fission hybrid studies, 5:25064 (UCRL—84018)
TMX DEVICES/HIGH-FREQUENCY HEATING
Rf heating of mirrors, 5:24982 (UCID—18623)
TMX DEVICES/NEUTRON EMISSION
Neutron yield measurements on a TMX endplug, 5:25005 (UCRL—52923)
TMX DEVICES/PLASMA CONFINEMENT
Generating end plug potentials in tandem mirror plasma confinement by heating thermal particles so as to escape low density end stoppering plasmas (Patent), 5:24977
TMX DEVICES/PLASMA DIAGNOSTICS
Imaging system for obtaining space- and time-resolved plasma images on TMX, 5:24995 (UCRL—83805)
TMX DEVICES/PLUGGING
Generating end plug potentials in tandem mirror plasma confinement by heating thermal particles so as to escape low density end stoppering plasmas (Patent), 5:24977
TMX DEVICES/REVIEWS
Initial results of the Tandem Mirror Experiment (TMX) at the Lawrence Livermore Laboratory, 5:25006 (UCRL—84221)
TNT
(Trinitrotoluene.)
TNT/LIQUID WASTES
Evaluation of the ultraviolet-ozone and ultraviolet-oxidant treatment of pink water. Final report 6 June 1976-30 December 1977, 5:24317 (PB—300763)
TOKAMAK DEVICES
See also ALCATOR DEVICE
SPHEROMAK DEVICES
TEXT DEVICES
TOKAPOLE DEVICES
TOKAMAK DEVICES/ALFVEN WAVES
Stability of shear flow in a magnetized plasma, 5:25021
TOKAMAK DEVICES/BALLOONING INSTABILITY
Study of MHD instabilities in elongated tokamaks, 5:25033
TOKAMAK DEVICES/CONVECTIVE INSTABILITIES
Characteristics and lifetime of convective plasma motions in tokamaks, 5:25034
TOKAMAK DEVICES/ECR HEATING
Theory of electron cyclotron resonance heating of tokamak plasmas, 5:24984
TOKAMAK DEVICES/ELECTRIC CURRENTS
Current generation by unidirectional lower hybrid waves in the ACT-1 toroidal device, 5:25003 (PPPL—1662)
TOKAMAK DEVICES/EQUILIBRIUM PLASMA
Energy principle with global invariants, 5:25017 (PPPL—1659)
TOKAMAK DEVICES/GROWTH
Convective amplification of drift waves and thermal fluctuation levels in a stable plasma, 5:25040

TOKAMAK DEVICES/PLASMA DIAGNOSTICS
UHV compatible chopper system, 5:25000
TOKAMAK DEVICES/PLASMA DRIFT
Convective amplification of drift waves and thermal fluctuation levels in a stable plasma, 5:25040
TOKAMAK DEVICES/PLASMA WAVES
Current generation by unidirectional lower hybrid waves in the ACT-I toroidal device, 5:25003 (PPPL—1662)
TOKAMAK DEVICES/PRESSURE VESSELS
Review of the wall problem and conditioning techniques for tokamaks, 5:25091 (PPPL—1666)
TOKAMAK DEVICES/TRANSPORT THEORY
Hydrogen recycle modeling in transport codes, 5:25010 (CONF-791057—4)
TOKAMAK TYPE REACTORS
See also ISX TOKAMAK
TFTR REACTORS
TOKAMAK TYPE REACTORS/AUGER ELECTRON SPECTROSCOPY
Fifteen-centimeter-diameter UHV transfer system for remote plasma-wall interaction experiments, 5:25094
TOKAMAK TYPE REACTORS/ELECTRIC GROUNDS
Safety grounding switches in large experiments; general considerations and the TEXT application, 5:25061
TOKAMAK TYPE REACTORS/ION MICROPROBE ANALYSIS
Fifteen-centimeter-diameter UHV transfer system for remote plasma-wall interaction experiments, 5:25094
TOKAMAK TYPE REACTORS/MASS SPECTROSCOPY
Fifteen-centimeter-diameter UHV transfer system for remote plasma-wall interaction experiments, 5:25094
TOKAMAK TYPE REACTORS/PHOTOELECTRON SPECTROSCOPY
Fifteen-centimeter-diameter UHV transfer system for remote plasma-wall interaction experiments, 5:25094
TOKAMAK TYPE REACTORS/PLASMA CONFINEMENT
Thermal responses of first wall limiters in the Tokamak Fusion Test Reactor, 5:25100
TOKAMAK TYPE REACTORS/SHIELDING
Shielding of fusion reactors, 5:25085 (CONF-791058—75)
TOKAPOLE DEVICES/IMPURITIES
Vacuum ultraviolet spectroscopic study of plasma impurities in the Tokapole II poloidal, 5:25001
TOMOGRAPHY
See also CAT SCANNING
TOMOGRAPHY/IMAGE PROCESSING
Overview of image reconstruction, 5:25105 (BNL—27665)
TOOLS/DESIGN
High-temperature, high-pressure bonding of nested tubular metallic components (Patent), 5:24568
TOPOLOGY
Which grids are Hamiltonian?, 5:25112 (SAND—80-0438C)
TOTAL ENERGY SYSTEMS/STIRLING ENGINES
Design and development of Stirling Engines for stationary power generation applications in the 500 to 3000 hp range. Subtask 1A report: state-of-the-art conceptual design, 5:24010 (DOE/ET/15209—T1)
TOTAL ENERGY SYSTEMS/TEST FACILITIES
Solar total energy project at the Sandia Laboratories Midtemperature Solar Systems Test Facility (MSSTF), 5:23861 (SERI/TP—333-429)
TOWER FOCUS COLLECTORS/DESIGN
Central receiver solar energy system for an oil refinery, 5:23917 (SERI/TP—333-429)
TOWER FOCUS POWER PLANTS
Utility views on solar thermal central receivers, 5:23858 (SAND—80-8203)
TOXIC MATERIALS
Toxic trace elements and oil shale production, 5:23656
TRACKS
See PARTICLE TRACKS
TRAFFIC CONTROL/COMPUTERIZED SIMULATION
Analyzing the FREQ3CP freeway operations simulation model. Research report, 5:24276 (PB—301117)
TRANS 104 ELEMENTS/NUCLEOSYNTHESIS
Superheavy elements, 5:24934
TRANS 104 ELEMENTS/STABILITY
Superheavy elements, 5:24934
TRANSFER (HEAT)
See HEAT TRANSFER
TRANSFER RNA/HYBRIDIZATION
Transcription of yeast mitochondrial deoxyribonucleic acid, 5:24684
TRANSIENT SPECIES
See REACTION INTERMEDIATES
TRANSIENTS/TEMPERATURE GRADIENTS
TEMP: a computer code to calculate fuel pin temperatures during a transient (LMFBR), 5:24093 (HEDL-TME—75-85)
TRANSITIONS (ENERGY LEVEL)
See ENERGY-LEVEL TRANSITIONS
TRANSITIONS (PHASE)
See PHASE TRANSFORMATIONS
TRANSMISSION LINES
See POWER TRANSMISSION LINES
TRANSPORT
(Limited to the movement of goods and persons.)
See also MARITIME TRANSPORT
TRANSPORT/COMPARATIVE EVALUATIONS
Critical issues in coal transportation systems, 5:23543
TRANSPORT/ECONOMICS
Economics of barge transport of coal, 5:23552
Overall economics in transportation of coal for export (Optimization of combined transport methods), 5:23547
TRANSPORT/MEETINGS
Critical issues in coal transportation systems, 5:23543
TRANSPORT/REGULATIONS
Selected regulatory issues affecting coal transportation requirements, 5:23550
TRANSPORT THEORY/DIMENSIONS
Calculation of ionization frequency distributions in small sites, 5:24722
TRANSPORTATION SECTOR/AIR POLLUTION CONTROL
Transortation Control Plan. Volume 3: Technical Documentation (Plan for control of traffic-related air pollution in Baltimore metropolitan area through 1987), 5:24599 (PB—297525)
TRANSPORTATION SYSTEMS
See also MASS TRANSIT SYSTEMS
RAPID TRANSIT SYSTEMS
TRANSPORTATION SYSTEMS/ATTITUDES
Analysis of user cost and service trade-offs in transit and paratransit services, 5:24284 (UMTA-MA—06-0049-79-10)
TRANSPORTATION SYSTEMS/CAPITAL
Overview of critical issues in coal transportation systems (Forecasting to 1985), 5:23545
TRANSPORTATION SYSTEMS/CHARGES
Analysis of user cost and service trade-offs in transit and paratransit services, 5:24284 (UMTA-MA—06-0049-79-10)
TRANSPORTATION SYSTEMS/DATA BASE MANAGEMENT
Freight transportation energy use. Volume III. Freight network and operations database. Final report August 1976-October 1978, 5:24280 (PB—301155)
TRANSPORTATION SYSTEMS/ECONOMIC ANALYSIS
Procedures for multi-state multi-mode analysis: second year's research. Volume II. Final report, 5:24275 (PB—300814)
TRANSPORTATION SYSTEMS/ECONOMIC DEVELOPMENT
Procedures for multi-state multi-mode analysis: second year's research. Volume II. Final report, 5:24275 (PB—300814)
TRANSPORTATION SYSTEMS/ENERGY CONSERVATION
Evaluation of the State Energy Conservation Program from program initiation to September 1978. Final report, 5:24191 (DOE/CS/1697—01)
Freight transportation energy use. Volume IV. Analysis of selected energy conservation options. Final report August 1976-October 1978, 5:24281 (PB—301156)
TRANSPORTATION SYSTEMS/ENERGY CONSUMPTION
Automobile mode: present status and future role, 5:24287
Current issues in statewide transportation planning, 5:24282 (PB—301172)
Freight transportation energy use, 5:24277 (PB—301152-SET/SL)
Freight transportation energy use. Volume II. Methodology and program documentation. Final report August 1976-October 1978, 5:24279 (PB—301154)
Rail as an industry, 5:24273
TRANSPORTATION SYSTEMS/ENERGY EFFICIENCY
Energy efficiency of various transportation modes, 5:24263 (PB—299994)
TRANSPORTATION SYSTEMS/ENERGY MODELS
Freight transportation energy use. Volume II. Methodology and program documentation. Final report August 1976-October 1978, 5:24279 (PB—301154)
TRANSPORTATION SYSTEMS/ENERGY POLICY
Contributions to the foundations of supply for energy and transportation: concepts, economics, and technologies, 5:24264 (PB—300541)
TRANSPORTATION SYSTEMS/ENERGY SOURCES
Contributions to the foundations of supply for energy and transportation: concepts, economics, and technologies, 5:24264 (PB—300541)
TRANSPORTATION SYSTEMS/FINANCING
Coal transportation systems performance, a current assessment (Ability to respond to strikes, bad weather, small volume shipments, etc.), 5:23555

TRANSPORTATION SYSTEMS/FUEL CONSUMPTION
Freight transportation energy use. Volume I. Summary and baseline results. Final report August 1976-October 1978, 5:24278 (PB—301153)
Freight transportation energy use. Volume III. Freight network and operations database. Final report August 1976-October 1978, 5:24280 (PB—301155)
TRANSPORTATION SYSTEMS/INVESTMENT
Overview of critical issues in coal transportation systems (Forecasting to 1985), 5:23545
TRANSPORTATION SYSTEMS/MANAGEMENT
Improving the intercity bus through transportation systems management, 5:24288
TRANSPORTATION SYSTEMS/MEETINGS
Opportunities in Canadian Transportation, 5:24272
Opportunities in Canadian transportation, 5:24285
TRANSPORTATION SYSTEMS/PLANNING
Characteristics of urban transportation systems: a handbook for transportation planners. Final report, 5:24283 (PB—301319)
Coal transportation systems performance, a current assessment (Ability to respond to strikes, bad weather, small volume shipments, etc.), 5:23555
Current issues in statewide transportation planning, 5:24282 (PB—301172)
TRANSPORTATION SYSTEMS/RATE STRUCTURE
Coal transportation systems performance, a current assessment (Ability to respond to strikes, bad weather, small volume shipments, etc.), 5:23555
TRANSPORTATION SYSTEMS/TECHNOLOGY ASSESSMENT
Contributions to the foundations of supply for energy and transportation: concepts, economics, and technologies, 5:24264 (PB—300541)
TRANSURANIUM ELEMENTS
See also NEPTUNIUM
PLUTONIUM
TRANSURANIUM ELEMENTS/RADIOACTIVE WASTE MANAGEMENT
Transuranic contaminated waste functional definition and implementation, 5:23751 (UCRL—15229)
TRAPPED ELECTRONS/RECOMBINATION
Upper limit to the excited electron-cation recombination lifetimes of trapped electrons in ethanol and 2-methyl-tetrahydrofuran glasses at 4 and 77 K, 5:24501
TRICKLE-TYPE COLLECTORS/DESIGN
Self-contained solar greenhouse (Patent), 5:23893
Solar radiation collector and water cooler (Patent), 5:23967
TRI-GAS PROCESS/PROCESS DEVELOPMENT UNITS
Test and evaluate the TRI-GAS low-Btu coal gasification process. Quarterly report, January-March 1980, 5:23418 (DOE/ET/10254—T2)
TRIGLYCERIDES/METABOLISM
Changes in plasma lipoprotein distribution and formation of two unusual particles after heparin-induced lipolysis in hypertriglyceridemic subjects, 5:24718
TRINITROTOLUENE
See TNT
TRITICUM
See WHEAT
TRITIUM/CONTAINERS
Effect of container preparation on the growth of protium and methane impurities into tritium gas, 5:25095
TRITIUM/DESORPTION
Transient getter scheme for the Tokamak Fusion Test Reactor, 5:25099
TRITIUM/ENVIRONMENTAL IMPACTS
Preliminary analysis of the safety and environmental impact of the Tritium Systems Test Assembly, 5:25068 (LA-UR—80-1249)
TRITIUM/OXIDATION
Removal of tritium and tritium-containing compounds from a gaseous stream (Patent), 5:23764
TRITIUM/RADIOACTIVE WASTE DISPOSAL
Gas generation by self-radiolysis of tritiated waste materials, 5:23753
TRITIUM/RADIOACTIVE WASTE PROCESSING
Performance and improvements of the tritium handling facility at the Los Alamos Scientific Laboratory, 5:23721 (LA-UR—80-1265)
TRITIUM/RADIOMETRIC ANALYSIS
Ionization chamber for measurements of high-level tritium gas, 5:24489 (LA-UR—80-1215)
TRITIUM/SCINTILLATION COUNTING
Critical examination of some newly available standards for liquid scintillation counting, 5:24720
TRITIUM COMPOUNDS/OXIDATION
Removal of tritium and tritium-containing compounds from a gaseous stream (Patent), 5:23764
TRITIUM OXIDES/ADSORPTION
Removal of tritium and tritium-containing compounds from a gaseous stream (Patent), 5:23764
TRITIUM RECOVERY
Design and construction of the Tritium Systems Test Assembly, 5:25067 (LA-UR—80-1203)
Fuel cleanup system for the tritium systems test assembly: design and experiments, 5:25069 (LA-UR—80-1273)
Preliminary analysis of the safety and environmental impact of the Tritium Systems Test Assembly, 5:25068 (LA-UR—80-1249)
Tritium Systems Test Assembly: objectives and design, 5:25066 (LA-UR—79-2971)
TRITIUM TARGET/DEUTERON REACTIONS
Low-energy nuclear fusion data and their relation to magnetic and laser fusion, 5:24890 (LA—8087)
TRITIUM TARGET/TRITON REACTIONS
Low-energy nuclear fusion data and their relation to magnetic and laser fusion, 5:24890 (LA—8087)
TRITON REACTIONS/COMPOUND-NUCLEUS REACTIONS
Low-energy nuclear fusion data and their relation to magnetic and laser fusion, 5:24890 (LA—8087)
TRITON REACTIONS/STRIPPING
Search for nuclear structure dependence of analyzing powers for the (t,p) reaction in medium mass nuclei, 5:24917
W(p,t) reactions. I. Even targets, 5:24924
TRITON REACTIONS/TWO-NUCLEON TRANSFER REACTIONS
Search for nuclear structure dependence of analyzing powers for the (t,p) reaction in medium mass nuclei, 5:24917
TRUCKS/MAINTENANCE
Weatherization training; a notebook for weatherization. Supplement Number 3: transportation, 5:24256 (PB—301143)
TRUCKS/PROCUREMENT
Weatherization training; a notebook for weatherization. Supplement Number 3: transportation, 5:24256 (PB—301143)
TUBES
(For objects of tubular shape; not for DRIFT TUBES, ELECTRON TUBES or IMAGE STORAGE TUBES.)
TUBES/BONDING
High-temperature, high-pressure bonding of nested tubular metallic components (Patent), 5:24568
TUBES/STANDARDS
Nuclear standards transmittal, 5:24067 (RDT-M—3-34T(4-80)(Rev.))
Nuclear standards transmittal, 5:24068 (RDT-M—3-4T(4-80)(Rev.))
TUBES (CONDUITS)
See PIPES
TUFF/THERMAL ANALYSIS
Pretest thermal analysis of the Tuff Water Migration/In-Situ Heater Experiment, 5:23742 (SAND—79-1278)
TUMORS
See NEOPLASMS
TUNGSTEN/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
TUNGSTEN/CHEMICAL BONDS
Microscopic theory of thermal desorption and dissociation processes catalyzed by a solid surface, 5:24959
TUNGSTEN/SORPTIVE PROPERTIES
Microscopic theory of thermal desorption and dissociation processes catalyzed by a solid surface, 5:24959
TUNGSTEN/SURFACE COATING
Coated woven materials and method of preparation (Patent), 5:24453
TUNGSTEN 180/ENERGY LEVELS
W(p,t) reactions. I. Even targets, 5:24924
TUNGSTEN 180/ENERGY-LEVEL TRANSITIONS
Decay of ^{180}Re: Search for octupole states in ^{180}W, 5:24921
TUNGSTEN 180/HIGH SPIN STATES
Decay of ^{180}Re: Search for octupole states in ^{180}W, 5:24921
TUNGSTEN 180 TARGET/PROTON REACTIONS
W(p,t) reactions. I. Even targets, 5:24924
TUNGSTEN 180 TARGET/TRITON REACTIONS
W(p,t) reactions. I. Even targets, 5:24924
TUNGSTEN 181/ENERGY LEVELS
W(p,t) reactions. II. Odd target, 5:24925
TUNGSTEN 182/ENERGY LEVELS
W(p,t) reactions. I. Even targets, 5:24924
TUNGSTEN 182 TARGET/PROTON REACTIONS
W(p,t) reactions. I. Even targets, 5:24924
TUNGSTEN 183 TARGET/PROTON REACTIONS
W(p,t) reactions. II. Odd target, 5:24925
TUNGSTEN 184/ENERGY LEVELS
W(p,t) reactions. I. Even targets, 5:24924
TUNGSTEN 184 TARGET/PROTON REACTIONS
W(p,t) reactions. I. Even targets, 5:24924
TUNGSTEN 186 TARGET/PROTON REACTIONS
W(p,t) reactions. I. Even targets, 5:24924

TUNNELS/COORDINATES
Cross-borehole electromagnetic probing to locate high-constrast anomalies, 5:24787
TURBINES
See also GAS TURBINES
TURBINES/PROTECTIVE COATINGS
Advanced electron beam techniques for metallic and ceramic protective coating systems, 5:24293 (LBL—10520)
TURNOVER (RADIONUCLIDES)
See RADIONUCLIDE KINETICS
TWO-PHASE FLOW/PHASE TRANSFORMATIONS
Two-phase vapour-liquid flow with phase change, review, 5:24529 (PB—299905)
TYPE-II SUPERCONDUCTORS/MATHEMATICAL MODELS
General critical state model in two dimensions and zero applied field: A uniqueness theorem and some consequences, 5:24968
TYPE-III SUPERCONDUCTORS
See TYPE-II SUPERCONDUCTORS

U

UCLBL
See LAWRENCE BERKELEY LABORATORY
UJM
See JET MODEL
ULTRACENTRIFUGE ENRICHMENT PLANTS
See CENTRIFUGE ENRICHMENT PLANTS
ULTRASONIC WAVES/BIOLOGICAL EFFECTS
Modification by cysteamine of ultrasound lethality to Chinese hamster V-79 cells, 5:24779
ULTRASONICS
See ULTRASONIC WAVES
ULTRAVIOLET RADIATION/BIOLOGICAL RADIATION EFFECTS
Repair of ultraviolet light damage to the DNA of cultured human epidermal keratinocytes and fibroblasts, 5:24742
Xeroderma pigmentosum variants have a slow recovery of DNA synthesis after irradiation with ultraviolet light, 5:24743
ULTRAVIOLET RADIATION/MUTAGENESIS
Ultraviolet-induced reversion of cyc1 alleles in radiation-sensitive strains of yeast. III. rev 3 mutant strains, 5:24745
UNCORRELATED-JET MODEL
See JET MODEL
UNDERGROUND MINING/AIR POLLUTION CONTROL
The application of advanced mine air monitoring techniques to mines using diesel powered equipment. Annual report no. 2, January 1977-June 1978, 5:23569 (PB—300724)
UNDERGROUND MINING/BACKFILLING
Fly ash/cement grouts for mine backfilling, 5:23510 (METC/SP—79/10(Pt.2))
UNDERGROUND MINING/DIESEL ENGINES
Control technology for diesel equipment in the underground mining environment - a review of selected topics. Final report 23 August 1978-31 January 1979, 5:24520 (PB—299946)
UNDERGROUND MINING/GROUND SUBSIDENCE
Evaluation of European empirical methods for subsidence in US coal fields, 5:23538 (SAND—80-0537)
UNDERWATER OPERATIONS
See also OFFSHORE OPERATIONS
UNDERWATER OPERATIONS/MANIPULATORS
Method and apparatus for recovery of subsea well equipment (Patent), 5:23582
UNIFIED GAUGE MODELS
See also WEINBERG-SALAM GAUGE MODEL
UNIFIED GAUGE MODELS/SYMMETRY BREAKING
Dynamical criteria for a unified gauge theory (including gravity), 5:24876 (COO—3075-224)
UNITED KINGDOM/SOLAR ENERGY
Solar energy in Europe, 5:23796
UNITED STATES OF AMERICA
See USA
UNIVERSE/PHASE TRANSFORMATIONS
Phase transitions and magnetic monopole production in the very early universe, 5:24800
UNLOADING (REACTOR)
See REACTOR FUELING
UPWELLING/BIOLOGICAL EFFECTS
Consequences of natural upwelling in oligotrophic marine ecosystems, 5:23862 (BNL—27710)
URANIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States, 5:23697 (LA-UR—80-1013)
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
URANIUM/EMISSION SPECTROSCOPY
Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States, 5:23697 (LA-UR—80-1013)
URANIUM/FLUORESCENCE SPECTROSCOPY
Evaluation of a laser-induced fluorescence system for uranium analysis, 5:24491 (Y—2205)
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
URANIUM/FLUOROSCOPY
Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States, 5:23697 (LA-UR—80-1013)
URANIUM/GAMMA SPECTROSCOPY
Investigations of the uranium potential along the Proterozoic unconformity in the Van Horn Areas, Texas. Final report, 5:23688 (GJBX—97(80))
URANIUM/INVESTMENT
Perspectives of the uranium industry, 5:23713
URANIUM/MEETINGS
Uranium resource/technology update: front end of the nuclear fuel cycle, 5:23711
URANIUM/MUONIC ATOMS
Actinide muonic atom lifetimes deduced from muon-induced fission, 5:24937
URANIUM/NEUTRON DETECTION
Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States, 5:23697 (LA-UR—80-1013)
URANIUM/PHOTON TRANSPORT
Z dependence of the laser-intensity threshold for inhibited electron thermal conduction, 5:24951
URANIUM/PRECIPITATION
Uranium recovery from wet-process phosphoric acid (Patent), 5:23700
URANIUM/RADIATION MONITORING
Studies of long-term ecological effects of exposure to uranium V, 5:24647 (LA—8221)
URANIUM/RECOVERY
Comparison of dielectric heating and pyrolysis of eastern and western oil shales (IITRI RF Process; leaching of U), 5:23632
Uranium recovery from wet-process phosphoric acid (Patent), 5:23700
URANIUM/SUPPLY AND DEMAND
Commercial development considerations, 5:23712
URANIUM/X-RAY FLUORESCENCE ANALYSIS
Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States, 5:23697 (LA-UR—80-1013)
URANIUM 233/BIOLOGICAL HALF-LIFE
Short term kinetics of uranium in the adult baboon: preliminary data, 5:24760 (COO—3382-18)
URANIUM 233/DELAYED NEUTRON ANALYSIS
Nondestructive fissile isotopic measurement technique for Uranium-233 - Uranium-235 fuels using prompt and delayed fission neutron counting, 5:24483
URANIUM 233/METABOLISM
Improved mathematical model for uranium metabolism, 5:24753 (COO—3382-18)
Radioactivity studies progress report (Lead abstract), 5:24755 (COO—3382-18)
URANIUM 233/NUCLEAR REACTION ANALYSIS
Nondestructive fissile isotopic measurement technique for Uranium-233 - Uranium-235 fuels using prompt and delayed fission neutron counting, 5:24483
URANIUM 233/RETENTION
Short term kinetics of uranium in the adult baboon: preliminary data, 5:24760 (COO—3382-18)
URANIUM 233/TISSUE DISTRIBUTION
Improved mathematical model for uranium metabolism, 5:24753 (COO—3382-18)
Radioactivity studies progress report (Lead abstract), 5:24755 (COO—3382-18)
Short term kinetics of uranium in the adult baboon: preliminary data, 5:24760 (COO—3382-18)
URANIUM 235/DELAYED NEUTRON ANALYSIS
Nondestructive fissile isotopic measurement technique for Uranium-233 - Uranium-235 fuels using prompt and delayed fission neutron counting, 5:24483
URANIUM 235/NUCLEAR REACTION ANALYSIS
Nondestructive fissile isotopic measurement technique for Uranium-233 - Uranium-235 fuels using prompt and delayed fission neutron counting, 5:24483

URANIUM 235 TARGET/MUON REACTIONS
Actinide muonic atom lifetimes deduced from muon-induced fission, 5:24937
URANIUM 237/BIOLOGICAL HALF-LIFE
Short term kinetics of uranium in the adult baboon: preliminary data, 5:24760 (COO—3382-18)
URANIUM 237/METABOLISM
Improved mathematical model for uranium metabolism, 5:24753 (COO—3382-18)
Radioactivity studies progress report (Lead abstract), 5:24755 (COO—3382-18)
URANIUM 237/RETENTION
Short term kinetics of uranium in the adult baboon: preliminary data, 5:24760 (COO—3382-18)
URANIUM 237/TISSUE DISTRIBUTION
Improved mathematical model for uranium metabolism, 5:24753 (COO—3382-18)
Radioactivity studies progress report (Lead abstract), 5:24755 (COO—3382-18)
Short term kinetics of uranium in the adult baboon: preliminary data, 5:24760 (COO—3382-18)
URANIUM 238 TARGET/MUON REACTIONS
Actinide muonic atom lifetimes deduced from muon-induced fission, 5:24937
URANIUM 238 TARGET/NEUTRON REACTIONS
Energy dependence of the ^{238}U thermal capture cross section (25 to 450°C), 5:24936 (DP-MS—79-106)
URANIUM BASE ALLOYS/CORROSION
Corrosion behavior of lean uranium-titanium alloys, 5:24414 (SAND—80-8215)
URANIUM BASE ALLOYS/OXIDATION
Corrosion behavior of lean uranium-titanium alloys, 5:24414 (SAND—80-8215)
URANIUM CARBIDES/REPROCESSING
Reprocessing nuclear fuels of the future: a radiological assessment of advanced (Th,U) carbide fuel, 5:23704
URANIUM CARBIDES/THERMAL CONDUCTIVITY
Thermal conductivities of mixed carbide fuel and blanket materials, 5:24058 (LA-UR—80-1283)
URANIUM CARBIDES/THERMAL DIFFUSIVITY
Thermal conductivities of mixed carbide fuel and blanket materials, 5:24058 (LA-UR—80-1283)
URANIUM DEPOSITS/AERIAL PROSPECTING
Aerial gamma ray and magnetic survey: Idaho Project, Nemo Detail Area, South Dakota. Final report, 5:23686 (GJBX—96(80)(Vol.1))
Aerial gamma ray and magnetic survey: Idaho Project, Nemo Detail Area, South Dakota. Final report, 5:23687 (GJBX—96(80)(Vol.2))
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
Aerial radiometric and magnetic survey: Adel National Topographic Map, Oregon. Rocky Mountain, 1979, 5:23692 (GJBX—104(80))
Aerial radiometric and magnetic survey: Phenix City National Topographic Map, Alabama/Georgia, Southeast US Project 1979, 5:23691 (GJBX—101(80))
Aerial radiometric and magnetic survey: Jordan Valley National Topographic Map, Idaho and Oregon. Rocky Mountain, 1979, 5:23685 (GJBX—95(80))
Airborne gamma-ray spectrometer and magnetometer survey: Nulato quadrangle (Alaska). Final report, 5:23677 (GJBX—73(80)(Vol.1))
Airborne gamma-ray spectrometer and magnetometer survey: Nulato quadrangle (Alaska). Final report, 5:23678 (GJBX—73(80)(Vol.2))
Airborne gamma-ray spectrometer and magnetometer survey: Sleetmute quadrangle (Alaska). Final report, 5:23679 (GJBX—79(80)(Vol.1))
Airborne gamma-ray spectrometer and magnetometer survey: Sleetmute quadrangle (Alaska). Final report, 5:23680 (GJBX—79(80)(Vol.2))
Airborne gamma-ray spectrometer and magnetometer survey: Iditarod quadrangle (Alaska). Final report, 5:23681 (GJBX—80-(80)(Vol.1))
URANIUM DEPOSITS/EXPLORATION
Investigations of the uranium potential along the Proterozoic unconformity in the Van Horn Areas, Texas. Final report, 5:23688 (GJBX—97(80))
Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States, 5:23697 (LA-UR—80-1013)
Uranium exploration (Review), 5:23698
URANIUM DEPOSITS/GAMMA LOGGING
Thin, dipping ore zone logging models. Log studies, 5:23676 (GJBX—54(80))
URANIUM DEPOSITS/PROSPECTING
Great Divide Basin drilling project Sweetwater County, Wyoming, 5:23675 (GJBX—51(80))
Hydrogeochemical and stream sediment reconnaissance basic data for Dickinson NTMS Quadrangle, North Dakota, 5:23689 (GJBX—99(80))
Hydrogeochemical and stream sediment detailed geochemical survey for Laramie Range, Wyoming, 5:23690 (GJBX—100(80))
Hydrogeochemical and stream sediment reconnaissance basic data for Marquette NTMS Quadrangle, Michigan, 5:23693 (GJBX—106(80))
URANIUM DEPOSITS/RADIOACTIVITY LOGGING
NDA technology for uranium resource evaluation. Progress report, January 1-June 30, 1979, 5:23696 (LA—8321-PR)
URANIUM DIOXIDE/CREEP
Grain-boundary diffusion in uranium dioxide: the correlation between sintering and creep and a reinterpretation of creep mechanism, 5:24432
URANIUM DIOXIDE/FISSION PRODUCT RELEASE
Effect of open porosity on the re-solution of fission gas from grain-edge bubbles, 5:24424
URANIUM DIOXIDE/GRAIN BOUNDARIES
Grain-boundary diffusion in uranium dioxide: the correlation between sintering and creep and a reinterpretation of creep mechanism, 5:24432
URANIUM DIOXIDE/PHYSICAL RADIATION EFFECTS
Effect of open porosity on the re-solution of fission gas from grain-edge bubbles, 5:24424
URANIUM DIOXIDE/SINTERING
Grain-boundary diffusion in uranium dioxide: the correlation between sintering and creep and a reinterpretation of creep mechanism, 5:24432
URANIUM HEXAFLUORIDE/TRANSPORT
Cylinder overpack phenolic foam shock testing, 5:24518 (K/P—6567)
URANIUM MILLS
See FEED MATERIALS PLANTS
URANIUM MINES/ECONOMICS
Commercial development considerations, 5:23712
URANIUM MINES/WATER REQUIREMENTS
State policies and requirements for management of uranium mining and milling in New Mexico. Volume II. Water availability in the San Juan Structural Basin, 5:23754 (SAND—78-1331)
URANIUM ORES/ORE PROCESSING
Uranium milling, 5:23701
URANIUM ORES/SOLUTION MINING
Solution mining of uranium, 5:23699
URANIUM RESERVES/FORECASTING
Probabilistic endowment appraisal system based upon the formalization of geologic decisions. General description, 5:23673 (GJBX—112(80))
URANIUM RESERVES/MATHEMATICAL MODELS
Probabilistic endowment appraisal system based upon the formalization of geologic decisions. General description, 5:23673 (GJBX—112(80))
URANIUM RESERVES/RESOURCE ASSESSMENT
Department of Energy's Uranium Resource Assessment activities (NURE), 5:23674
URBAN AREAS/AIR POLLUTION
Evaluation of particulate emission factors for vehicle tire wear. Final report, 5:24609 (PB—300443)
URBAN AREAS/AIR QUALITY
Air quality data for nonmetallic inorganic ions: NH4+, NO3-, SO4= from the National Air Surveillance Networks, 1976. Final report, 5:24610 (PB—300458)
URBAN AREAS/AUTOMOBILES
Emergency of the auto as the free vote mode, 5:24286
URBAN AREAS/DECISION MAKING
Overall city technology process. Final report, 5:24321 (PB—301109)
URBAN AREAS/DISTRICT HEATING
Evaluation of thermal energy storage for a large urban hot water district heating system in the United States, 5:24101 (CONF-7910152—1)
URBAN AREAS/EMPLOYMENT
Urban subcenters: recent trends in urban spatial structure, 5:24183
URBAN AREAS/ENERGY CONSERVATION
Overall city technology process. Final report, 5:24321 (PB—301109)
URBAN AREAS/RAPID TRANSIT SYSTEMS
SLRV (standard light rail vehicle) engineering tests at department of transportation, transportation test center. Final test report. Volume II. Performance and power consumption tests. Final report January-June 1976, 5:24266 (PB—301147)
URBAN AREAS/SPACE HEATING
Energy-industry-environment system of Baden-Wuerttemberg, 5:24176 (IKE-K—54-19)

URBAN AREAS/TECHNOLOGY TRANSFER
Overall city technology process. Final report, 5:24321 (PB—301109)
URBAN AREAS/TRAFFIC CONTROL
Transortation Control Plan. Volume 3: Technical Documentation (Plan for control of traffic-related air pollution in Baltimore metropolitan area through 1987), 5:24599 (PB—297525)
URBAN AREAS/TRANSPORTATION SYSTEMS
Analysis of user cost and service trade-offs in transit and paratransit services, 5:24284 (UMTA-MA—06-0049-79-10)
Emergency of the auto as the free vote mode, 5:24286
Improving the intercity bus through transportation systems management, 5:24288
Opportunities in Canadian transportation, 5:24285
URBAN AREAS/WATER HEATERS
Energy-industry-environment system of Baden-Wuerttemberg, 5:24176 (IKE-K—54-19)
URBAN POPULATIONS/STATISTICAL MODELS
Urban subcenters: recent trends in urban spatial structure, 5:24183
US DOE
See also HANFORD RESERVATION
LASL
LAWRENCE BERKELEY LABORATORY
ORNL
ROCKY FLATS PLANT
SAVANNAH RIVER PLANT
STANFORD LINEAR ACCELERATOR CENTER
US DOE/DEMONSTRATION PROGRAMS
New DOE-funded projects (Indsutrial solar process heat), 5:23908 (SERI/TP—333-429)
Seven DOE intermediate temperature (350°F to 550°F) steam demonstration projects, 5:23907 (SERI/TP—333-429)
US DOE/PROFESSIONAL PERSONNEL
Department of Energy Procurement and Financial-Assistance Career Guide, 5:24173 (DOE/PR—0038)
US DOE/RESEARCH PROGRAMS
DOE Solar Thermal Power Systems Program, 5:23856 (SERI/TP—333-429)
US EPA/COORDINATED RESEARCH PROGRAMS
Bibliography of the Interagency Energy/Environment R and D Program, 5:24593 (EPA—600/9-79-015)
US EPA/POLLUTION REGULATIONS
Impact of proposed RCRA regulations on resource recovery and utilization, 5:23463 (METC/SP—79/10(Pt.1))
Low/medium Btu gasification: a summary of applicable EPA regulations, 5:23531
US EPA/RESEARCH PROGRAMS
Fiscal Year 1977 Research Program Abstracts of the Interagency Energy/Environment R & D Program, 5:24594 (EPA—600/9-79-016)
US NRC/DECISION MAKING
Formal analysis including value judgments and public risk, 5:24186 (UCRL—15226)
USA
See also ALABAMA
ALASKA
ARIZONA
CALIFORNIA
COLORADO
CONNECTICUT
FLORIDA
GEORGIA
HAWAII
IDAHO
INDIANA
IOWA
KANSAS
KENTUCKY
LOUISIANA
MARYLAND
MASSACHUSETTS
MICHIGAN
MINNESOTA
MISSISSIPPI
MONTANA
NEVADA
NEW MEXICO
NEW YORK
NORTH CAROLINA
NORTH DAKOTA
OHIO
OKLAHOMA
OREGON
PENNSYLVANIA
SOUTH CAROLINA
SOUTH DAKOTA
TEXAS
UTAH
VIRGINIA
WASHINGTON
WEST VIRGINIA
WYOMING
USA/BOREHOLES
LLL continental drilling for scientific purposes data base: DOE-funded drill holes, 5:24782 (UCRL—52909)
USA/ECONOMIC POLICY
Conservation and the changing direction of economic growth (Book; 6 papers), 5:24199
USA/ENERGY CONSERVATION
Evaluation of the State Energy Conservation Program from program initiation to September 1978. Final report, 5:24191 (DOE/CS/1697—01)
USA/ENERGY CONSUMPTION
National energy problem in perspective, 5:24194 (CONF-7910153—1)
USA/ENERGY DEMAND
Factors affecting US coal use in the next two decades, 5:23544
USA/ENERGY EFFICIENCY
Shifting MX expenditures to energy efficiency: memo on the national security implications of alternative energy development, 5:24192 (CEP-OP—0-2)
USA/ENERGY SOURCE DEVELOPMENT
Shifting MX expenditures to energy efficiency: memo on the national security implications of alternative energy development, 5:24192 (CEP-OP—0-2)
USA/ENERGY SUPPLIES
Conservation and the changing direction of economic growth (Book; 6 papers), 5:24199
Factors affecting US coal use in the next two decades, 5:23544
National energy problem in perspective, 5:24194 (CONF-7910153—1)
Policy and Fiscal Guidance: energy projections. Appendix D, 5:24196 (DOE/PE—00/8)
USA/GEOLOGY
Waste Isolation Safety Assessment Program. Technical progress report for FY-1978, 5:23737 (PNL—2874)
USA/GOVERNMENT POLICIES
Government procurement of recycled products: fly ash in cement and concrete, 5:23464 (METC/SP—79/10(Pt.1))
USA/HARBORS
Alternative modes of ocean transportation of coal, 5:23548
USA/HYDROLOGY
Waste Isolation Safety Assessment Program. Technical progress report for FY-1978, 5:23737 (PNL—2874)
USA/INSOLATION
Environmental data for sites in the National Solar Data Network, 5:23797 (SOLAR/0010—80/04)
USA/METEOROLOGY
Environmental data for sites in the National Solar Data Network, 5:23797 (SOLAR/0010—80/04)
USA/NATIONAL SECURITY
Shifting MX expenditures to energy efficiency: memo on the national security implications of alternative energy development, 5:24192 (CEP-OP—0-2)
USA/NUCLEAR ENERGY
Tentative outline of work scope and organization for a study of the risks from energy production in the US, 5:24080 (ALO—81)
USA/REGULATIONS
Factors affecting US coal use in the next two decades, 5:23544
USA/RESOURCE RECOVERY ACTS
Government procurement of recycled products: fly ash in cement and concrete, 5:23464 (METC/SP—79/10(Pt.1))
USA/SEISMOLOGY
Waste Isolation Safety Assessment Program. Technical progress report for FY-1978, 5:23737 (PNL—2874)
USA/TERMINAL FACILITIES
Alternative modes of ocean transportation of coal, 5:23548
USA/TRANSPORTATION SYSTEMS
Factors affecting US coal use in the next two decades, 5:23544
USA/WELDING
Welding industry. Potential for energy conservation, 5:24290 (EGG—2027)
USSR/GEOTHERMAL RESOURCES
Geothermal energy development in the Soviet Union, 5:23982
UTAH/BOOM TOWNS
Boomtown impacts of energy development in the Lake Powell Region (Lake Powell Research Project), 5:24665 (PB—301221)
UTAH/COAL DEPOSITS
Kaiparowits handbook, coal resources (Lake Powell Research Project, interim report), 5:23534 (PB—301108)
UTAH/ENERGY SOURCE DEVELOPMENT
Kaiparowits handbook, coal resources (Lake Powell Research Project, interim report), 5:23534 (PB—301108)
UTILITIES
See ELECTRIC UTILITIES
PUBLIC UTILITIES

V

VACUUM PUMPS
See also CRYOPUMPS
Methane outgassing from a Ti sublimation pump, 5:24558
VACUUM SYSTEMS/GLOW DISCHARGES
Glow discharge conditioning of the PDX vacuum vessel, 5:25097
VACUUM SYSTEMS/PERFORMANCE
Design and operational characteristics of the cryopump high-vacuum system for the 25 000-l target chamber of the Helios Laser Facility, 5:25096
VACUUM SYSTEMS/TOKAMAK TYPE REACTORS
Fifteen-centimeter-diameter UHV transfer system for remote plasma-wall interaction experiments, 5:25094
VALUES/ACOUSTIC MONITORING
Materials technology for coal-conversion processes. Nineteenth report, July-December 1979, 5:23417 (ANL—80-12)
VALUES/SENSITIVITY ANALYSIS
Formal analysis including value judgments and public risk, 5:24186 (UCRL—15226)
VALVES
See also RELIEF VALVES
VALVES/FAILURES
Pilot program to identify valve failures which impact the safety and operation of light water nuclear power plants, 5:24042 (ALO—75)
VANADIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
VANADIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
VANADIUM/ELECTRONIC STRUCTURE
Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
VANADIUM/EMISSION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
VANADIUM/ENERGY-LEVEL TRANSITIONS
Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
VANADIUM/REFLECTIVITY
Electronic structure of the bcc transition metals: Thermoreflectance studies of bulk V, Nb, Ta, and αTaH/sub x/, 5:24401
VANADIUM ALLOYS/CASTING
Fe-based long range ordered alloys (Patent), 5:24363
VANADIUM ALLOYS/ORDER PARAMETERS
Fe-based long range ordered alloys (Patent), 5:24363
VANPOOLING/GOVERNMENT POLICIES
Federal energy conservation programs pursuant to section 381 of the Energy Policy and Conservation Act (Public Law 94-163). Annual report to Congress, 5:24190 (DOE/CS—0162)
VAPOR DEPOSITED COATINGS/ALUMINIUM OXIDES
Quantitative characterization of high strength aluminum foils vapor deposited on curved surfaces, 5:24380
VARIABLE STARS/OSCILLATION MODES
Theoretical period ratios for RR Lyrae variables and AQ Leonis, 5:24795
VARIABLE STARS/STAR MODELS
Theoretical period ratios for RR Lyrae variables and AQ Leonis, 5:24795
VAVILOV-CHERENKOV RADIATION
See CHERENKOV RADIATION
VECTOR MESONS
(Mesons with spin-one.)
See also K-892 RESONANCES
PSI RESONANCES
RHO-765 RESONANCES
VECTOR MESONS/LEPTONIC DECAY
Addendum to "Hadronic corrections to the annihilation rateof heavy vector mesons to lepton pairs", 5:24865
VECTOR MESONS/PARTICLE WIDTHS
K/sub S/0* and its uses, 5:24860
VECTOR MESONS/PHOTOPRODUCTION
Recent results in photoproduction, 5:24836
VEHICLES
See also AUTOMOBILES
BUSES
ELECTRIC-POWERED VEHICLES
FLYWHEEL-POWERED VEHICLES
TRUCKS
VEHICLES/AIR POLLUTION
Three point program to reduce fuel consumption, traffic congestion, and air pollution - status report (connecticut), 5:24355 (PB—301224)
VEHICLES/ENERGY CONSERVATION
Energy management in the Federal Government, 5:24174 (DOE/S—0005(79))
VEHICLES/EXHAUST GASES
Analyzing the FREQ3CP freeway operations simulation model. Research report, 5:24276 (PB—301117)
Transortation Control Plan. Volume 3: Technical Documentation (Plan for control of traffic-related air pollution in Baltimore metropolitan area through 1987), 5:24599 (PB—297525)
VEHICLES/FUEL CONSUMPTION
Analyzing the FREQ3CP freeway operations simulation model. Research report, 5:24276 (PB—301117)
Three point program to reduce fuel consumption, traffic congestion, and air pollution - status report (connecticut), 5:24355 (PB—301224)
VEHICLES/POLLUTION CONTROL EQUIPMENT
An analysis of inspection-maintenance program options for Jefferson County, Kentucky. executive summary. Final report, 5:24606 (PB—299935)
VENTILATION SYSTEMS/COST
Optimization technique for minimizing the cost of self-powering industrial HVAC systems, 5:24304
VENTILATION SYSTEMS/DESIGN
Face ventilation system for coal mines (Patent), 5:23570
VESSELS
See CONTAINERS
VESSELS (PRESSURE)
See PRESSURE VESSELS
VIBRATIONS (MECHANICAL)
See MECHANICAL VIBRATIONS
VINOFLEX
See POLYVINYLS
VIRGINIA/MAGNETIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
VIRGINIA/RADIOMETRIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
VIRUSES
See also POLIO VIRUS
VIRUSES/ADSORPTION
Adsorption of enteroviruses to soil cores and their subsequent elution by artificial rainwater, 5:24726
VIRUSES/ECOLOGICAL CONCENTRATION
Survey of human enterovirus occurrence in fresh and marine surface waters on Long Island, 5:24731
VISIBLE RADIATION/POLARIZATION
Conventions and formulas for using the Mueller-Stokes calculus in ellipsometry, 5:24971 (LBL—10172)
VISIBLE RADIATION/STOKES PARAMETERS
Conventions and formulas for using the Mueller-Stokes calculus in ellipsometry, 5:24971 (LBL—10172)
VITAMIN C
See ASCORBIC ACID
VITAMIN D/METABOLISM
Regulation of vitamin D metabolism in the kidney, 5:24694
VOLTAIC CELLS
See ELECTRIC BATTERIES

W

WALLS/DAMAGE
Field study of moisture damage in walls insulated without a vapor barrier. Final report for the Oregon Department of Energy, 5:24245 (ORNL/Sub—78/97726/1)
WALLS/THERMAL INSULATION
Field study of moisture damage in walls insulated without a vapor barrier. Final report for the Oregon Department of Energy, 5:24245 (ORNL/Sub—78/97726/1)
WASHINGTON/GEOLOGY
Bibliography of the geology of the Columbia Basin and surrounding areas of Washington, 5:23739 (RHO-BWI-C—59)
WASTE DISPOSAL
See also RADIOACTIVE WASTE DISPOSAL

SANITARY LANDFILLS
WASTE DISPOSAL/COMPARATIVE EVALUATIONS
Evaluation of ash storage sites: a case history, 5:23479 (METC/SP—79/10(Pt.1))
WASTE DISPOSAL/ECONOMIC ANALYSIS
Evaluation of ash storage sites: a case history, 5:23479 (METC/SP—79/10(Pt.1))
WASTE DISPOSAL/ENVIRONMENTAL EFFECTS
Evaluation of ash storage sites: a case history, 5:23479 (METC/SP—79/10(Pt.1))
WASTE DISPOSAL/MANAGEMENT
Economic and environmental aspects of a new coal ash recycling/disposal process, 5:23481 (METC/SP—79/10(Pt.1))
WASTE HEAT UTILIZATION/FEASIBILITY STUDIES
Demonstration of energy conservation for multi-deck board dryers. Phase I. Final report, 5:24307 (DOE/CS/40167—T1)
WASTE PROCESSING
See also MATERIALS RECOVERY
RADIOACTIVE WASTE PROCESSING
WASTE PROCESSING/OPTIMIZATION
New developments in the lime-soda sinter process for recovery of alumina from fly ash, 5:23466 (METC/SP—79/10(Pt.1))
WASTE PRODUCT UTILIZATION
See also WASTE HEAT UTILIZATION
WASTE PRODUCT UTILIZATION/FEASIBILITY STUDIES
Dried, irradiated sewage solids as supplemental feed for cattle, 5:24331 (SAND—80-0989C)
WASTE PRODUCT UTILIZATION/LEGAL ASPECTS
Ash liability in cement replacement, 5:23488 (METC/SP—79/10(Pt.2))
WASTE PRODUCT UTILIZATION/LIABILITIES
Ash liability in cement replacement, 5:23488 (METC/SP—79/10(Pt.2))
WASTE SOLUTIONS
See LIQUID WASTES
WASTE WATER/CHEMICAL COMPOSITION
Environmental research on a modified in situ oil shale task process. Progress report, 5:23660 (DOE/EV—0078)
Treatment of waste water effluents from coal gasification units, 5:23434
WASTE WATER/HEALTH HAZARDS
Environmental research on a modified in situ oil shale task process. Progress report, 5:23660 (DOE/EV—0078)
WASTE WATER/WASTE PRODUCT UTILIZATION
Water management model for Front Range River Basins, 5:24008 (PB—299950)
WASTE WATER/WATER TREATMENT
Treatment of liquid effluents from coal gasification plants, 5:23515
Treatment of waste water effluents from coal gasification units, 5:23434
WASTES
See also GASEOUS WASTES
INDUSTRIAL WASTES
LIQUID WASTES
MUNICIPAL WASTES
RADIOACTIVE WASTES
SEWAGE
SOLID WASTES
WASTES/BIOCONVERSION
Management assessment of energy from biomass and wastes, 5:23839
WASTES/ENERGY SOURCE DEVELOPMENT
Management assessment of energy from biomass and wastes, 5:23839
WASTES/MEETINGS
Management assessment of energy from biomass and wastes, 5:23839
WATER
See also DRINKING WATER
GROUND WATER
SEAWATER
WATER/MONITORING
Groundwater quality monitoring of western oil shale development: identification and priority ranking of potential pollution sources, 5:23661 (PB—300536)
WATER/SEPARATION PROCESSES
Method for removing suspended oil droplets from water (Patent), 5:23587
WATER CHEMISTRY/DATA ACQUISITION
Summary of equilibrium and process model data acquisition: treatment of recirculated cooling water, Resource Document 1. Interim report, 5:24007 (EPRI-FP—1251)
WATER COOLED REACTORS
See also BWR TYPE REACTORS
PWR TYPE REACTORS
WATER COOLED REACTORS/ENVIRONMENTAL IMPACTS
Climate and energy: a comparative assessment of the Satellite Power System (SPS) and alternative energy technologies, 5:23798 (DOE/ER—0050)
Comparative assessment of environmental welfare issues associated with the satellite power system (SPS) and alternative technologies, 5:23849 (DOE/ER—0055)
WATER COOLED REACTORS/FUEL CYCLE
Overview of nuclear fuel cycle, 5:23671 (CONF-791185—3)
Spent fuel and fuel pool component integrity. Annual report, FY 1979, 5:23709 (PNL—3171)
WATER COOLED REACTORS/NET ENERGY
Comparative analysis of net energy balance for satellite power systems (SPS) and other energy systems, 5:23850 (DOE/ER—0056)
WATER DISTRIBUTION
See WATER SUPPLY
WATER HEATERS
See also ANNUAL CYCLE ENERGY SYSTEM
WATER HEATERS/ENERGY CONSUMPTION
Residential energy consumption survey: characteristics of the housing stock and households, 5:24253 (DOE/EIA—0207/2)
WATER POLLUTION/BIOLOGICAL INDICATORS
Plant developmental system to measure the impact of pollutants in rain water, 5:24768
WATER POLLUTION/FLOW MODELS
Effects of seepage from fly-ash settling ponds and construction dewatering on ground-water levels in the Cowles Unit, Indiana Dunes National Lakeshore, Indiana. Water-resources investigations (final) 1976-77, 5:24660 (PB—300843)
WATER POLLUTION/MATHEMATICAL MODELS
Effects of contour coal strip mining on stormwater runoff and quality, 5:23518 (ORO—4946-T1)
WATER POLLUTION/MONITORING
Outer continental shelf environmental monitoring concerns. Final report, 5:23607 (PB—299861)
WATER POLLUTION/STANDARDIZED TERMINOLOGY
Epa chemical activities status report, first edition, 5:24621 (PB—301366)
WATER POLLUTION/WATER POLLUTION MONITORS
Strategies for marine pollution monitoring, 5:24653
WATER POLLUTION ABATEMENT/COST
The cost of clean air and water. Report to Congress, 5:24637 (PB—300446)
WATER QUALITY/MATHEMATICAL MODELS
National environmental models of agricultural policy, land use and water quality. Progress report no. 4, 5:24649 (PB—300525)
WATER RESERVOIRS
See also COOLING PONDS
WATER RESERVOIRS/ENVIRONMENTAL IMPACTS
Lake Powell effect on Colorado River Basin water supply and environment (Lake Powell Research Project interim report), 5:24661 (PB—301068)
WATER RESOURCES/RESOURCE DEVELOPMENT
Water development in Wyoming: a study of resident attitudes, 1971. Completion report, 5:24657 (PB—300495)
WATER SUPPLY/MANAGEMENT
Water management for oil shale mining and retorting in the Piceance Creek Basin, Colorado, 5:23658
WATERFLOODING/SURFACTANTS
Oil recovery by waterflooding with thickened surfactant solutions (Patent), 5:23583
WAVE EQUATIONS/CORRELATION FUNCTIONS
Computation of mode properties in optical fiber waveguides by a propagating beam method, 5:24973
WAVE POWER/DATA PROCESSING
Wave measuring project for wave energy prospecting purpose, 5:24001 (SMHI-HBF-PM—229)
WAVE POWER/RESOURCE ASSESSMENT
Wave measuring project for wave energy prospecting purpose, 5:24001 (SMHI-HBF-PM—229)
WAVEGUIDES/OPTICAL MODES
Computation of mode properties in optical fiber waveguides by a propagating beam method, 5:24973
WAVES (SHOCK)
See SHOCK WAVES
WAZ 16
See NICKEL BASE ALLOYS
WEAR/MEASURING INSTRUMENTS
Study of the interactions between friction, wear and system rigidity. Progress report, July 1, 1979-June 30, 1980, 5:24509 (DOE/ER/10471—1)
WEATHERIZATION/EVALUATION
Project evaluation and quality control, 5:24262 (PB—301048)
WEATHERIZATION/FINANCIAL INCENTIVES
Selected federal tax and non-tax subsidies for energy use and production. Energy policy study, Volume 6. AR/EA/80-01, 5:24202 (DOE/EIA—0201/6)

WEATHERIZATION/QUALITY CONTROL
Project evaluation and quality control, 5:24262 (PB—301048)
WEINBERG-SALAM GAUGE MODEL/CP INVARIANCE
Gauge models of CP violation, 5:24873
WEINBERG-SALAM GAUGE MODEL/WEAK INTERACTIONS
Weak interaction of nucleons in the Weinberg-Salam model, 5:24863 (LA-tr—80-11)
WELDED JOINTS/FRACTURE PROPERTIES
Weldability of thermally grain-refined Fe-12Ni-0.25Ti for cryogenic structural applications, 5:24369 (LBL—10259)
WELDED JOINTS/HOT PRESSING
Process for treating weldments (Patent), 5:24365
WELDED JOINTS/PHASE STUDIES
Delta ferrite-containing austenitic stainless steel resistant to the formation of undesirable phases upon aging (Patent), 5:24360
WELDING
(All endothermic processes for material joining.)
WELDING/ENERGY CONSUMPTION
Welding industry. Potential for energy conservation, 5:24290 (EGG—2027)
WELDING MACHINES/ENERGY CONSUMPTION
Welding industry. Potential for energy conservation, 5:24290 (EGG—2027)
WELDS
See WELDED JOINTS
WELL DRILLING/RESEARCH PROGRAMS
Contracts for field projects and supporting research on enhanced oil recovery and improved drilling technology. Progress review No. 21, quarter ending December 31, 1979, 5:23576 (DOE/BETC—80/1)
WELL LOGGING EQUIPMENT
Borehole survey instrumentation development for geothermal applications, 5:23988 (LA-UR—80-670)
WELLS
See also GEOTHERMAL WELLS
NATURAL GAS WELLS
OIL WELLS
WELLS/GEOCHEMICAL SURVEYS
Geothermal investigation of spring and well waters of the Los Alamos Region, New Mexico, 5:23986 (LA—8326-MS)
WEST GERMANY
See FEDERAL REPUBLIC OF GERMANY
WEST VALLEY PROCESSING PLANT/RADIOACTIVE WASTE MANAGEMENT
Nuclear fuel services waste characterization and waste removal system, 5:23714 (RHO-CD—883)
WEST VIRGINIA/MAGNETIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
WEST VIRGINIA/RADIOMETRIC SURVEYS
Aerial radiometric and magnetic reconnaissance survey of portions of Alabama, Georgia, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. Volume 1. Instrumentation and methods. Final report, 5:23684 (GJBX—92(80))
WESTINGHOUSE GASIFICATION PROCESS/PROCESS DEVELOPMENT UNITS
Advanced coal gasification system for electric power generation. Quarterly progress report, October 1-December 31, 1978, 5:23421 (FE—1514-97)
WHEAT/PRODUCTION
Resource-conserving agricultural production methods. Progress report August 1977-July 1978, 5:24301 (PB—301042)
WHOLESALE PRICES/SUBSIDIES
State of competition in gasoline marketing. The effects of refiner operation at retail (a study required by Title III of the Petroleum Marketing Practices Act), 5:23600 (DOE/PE—0019(Vol.1))
WIND POWER/DEMONSTRATION PROGRAMS
Going with the wind, 5:24002
WIND POWER/RESEARCH PROGRAMS
Going with the wind, 5:24002
WIND TURBINES/DESIGN
Mod-1 wind turbine generator analysis and design report, 5:24005 (DOE/NASA/0058—79/2(Vol.1))
WIND TURBINES/ECONOMICS
Screening method for wind energy conversion systems, 5:24003 (SERI/TP—731-649)
WIND TURBINES/FEASIBILITY STUDIES
Screening method for wind energy conversion systems, 5:24003 (SERI/TP—731-649)
WIND TURBINES/SIMULATORS
Wind energy system time-domain (WEST) analyzers using hybrid simulation techniques, 5:24004 (DOE/NASA/0026—79/1)
WIND TURBINES/STRESS ANALYSIS
Mod-1 wind turbine generator analysis and design report, 5:24005 (DOE/NASA/0058—79/2(Vol.1))
WINKLER PROCESS/ECONOMICS
Winkler coal gasification process and its application in ammonia synthesis plants, 5:23783
WINKLER PROCESS/PILOT PLANTS
High-temperature Winkler coal gasification process, 5:23433
WINKLER PROCESS/SYNTHESIS GAS
Final sulfur removal in ammonia from coal plants, 5:23416
WINSTON COLLECTORS
See COMPOUND PARABOLIC CONCENTRATORS
WOOD/ACID HYDROLYSIS
Catalytic biomass liquefaction, 5:23836 (LBL—10667)
WOOD/CALORIFIC VALUE
Conversion factors fuelwood: oil, 5:23837 (SIU-IVI—110)
WOOD/LIQUEFACTION
Catalytic biomass liquefaction, 5:23836 (LBL—10667)
WOOD/SOLAR DRYING
Performance of a solar heating system for kiln drying lumber, 5:23922 (SERI/TP—333-429)
Review of four DOE-sponsored solar dehydration systems, 5:23906 (SERI/TP—333-429)
WOOD WASTES/MEETINGS
Utilizing bark and wood residues to solve technical problems, 5:24320
WOOD WASTES/WASTE PRODUCT UTILIZATION
Utilizing bark and wood residues to solve technical problems, 5:24320
WORKERS
See PERSONNEL
WORKING FLUIDS/COMPATIBILITY
Design study of a two-phase turbine bottoming cycle. Final report (Therminol 66 heated in diesel exhaust), 5:24309 (DOE/ET/15350—T1)
WORKING (MATERIALS)
See MATERIALS WORKING
WYOMING/COAL MINES
Evaluation of the environmental effects of western surface coal mining. Volume II. Mine inventory. Final report, 5:23529 (PB—301249)
WYOMING/ENERGY SOURCE DEVELOPMENT
The Yampa River Basin, Colorado and Wyoming--a preview to expanded coal-resource development and its impacts on regional water resources. Water-resources investigations (final), 5:24658 (PB—300815)
WYOMING/GEOCHEMICAL SURVEYS
Hydrogeochemical and stream sediment detailed geochemical survey for Laramie Range, Wyoming, 5:23690 (GJBX—100(80))
Los Alamos Scientific Laboratory approach to hydrogeochemical and stream sediment reconnaissance for uranium in the United States, 5:23697 (LA-UR—80-1013)
WYOMING/WATER RESOURCES
Water development in Wyoming: a study of resident attitudes, 1971. Completion report, 5:24657 (PB—300495)

X

X RADIATION/BIOLOGICAL RADIATION EFFECTS
Evidence for a change in the fluidity of erythrocyte membranes following x irradiation by measurement of pyrene excimer fluorescence, 5:24738
Synergism of diethylstilbestrol and radiation in mammary carcinogenesis in female F344 rats, 5:24749
X RADIATION/GENETIC RADIATION EFFECTS
Mutagenicity and cytotoxicity of 4.4-MeV α particles emitted by plutonium-238, 5:24739
X RADIATION/SIDE EFFECTS
Induction of lung tumors in RFM mice after localized exposures to x rays or neutrons, 5:24748
XENON/CHEMICAL BONDS
Microscopic theory of thermal desorption and dissociation processes catalyzed by a solid surface, 5:24959
XENON/DESORPTION
Microscopic theory of thermal desorption and dissociation processes catalyzed by a solid surface, 5:24959
XENON/SEPARATION PROCESSES
Effect of the degree of hydration of the adsorbent on the chromatographic analysis of common gases, 5:24493 (DP-TR—9)
XENON ISOTOPES/DAUGHTER PRODUCTS
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)

XENON ISOTOPES/ENVIRONMENTAL TRANSPORT
HARAD: a computer code for calculating daughter concentrations in air following the atmospheric release of a parent radionuclide, 5:24632 (ORNL—5634)
XP CELLS/RADIOSENSITIVITY
Xeroderma pigmentosum variants have a slow recovery of DNA synthesis after irradiation with ultraviolet light, 5:24743
X-RAY FLUORESCENCE ANALYSIS/NSLS
Use of a synchrotron radiation x-ray microprobe for elemental analysis at the National Synchrotron Light Source, 5:24487 (BNL—27611)
X-RAY SPECTROMETERS/SENSITIVITY
Soft x-ray imaging instrument for the Alcator A tokamak, 5:24999

Y

YANG-MILLS THEORY/CONSERVATION LAWS
Baeklund transformations, conservation laws and linearization of the self-dual Yang-Mills and chiral fields, 5:24875 (BNL—27617)
YANG-MILLS THEORY/INVERSE SCATTERING PROBLEM
Baeklund transformations, conservation laws and linearization of the self-dual Yang-Mills and chiral fields, 5:24875 (BNL—27617)
YANG-MILLS THEORY/TRANSFORMATIONS
Baeklund transformations, conservation laws and linearization of the self-dual Yang-Mills and chiral fields, 5:24875 (BNL—27617)
YEASTS/GENETIC RADIATION EFFECTS
Ultraviolet-induced reversion of cyc1 alleles in radiation-sensitive strains of yeast. III. rev 3 mutant strains, 5:24745
YTTERBIUM/ACTIVATION ANALYSIS
Challis 1° x 2° NTMS area Idaho: data report, 5:23683 (GJBX—91(80))
Reno 1° x 2° NTMS area Nevada: data report, 5:23695 (GJBX—108(80))
Walker Lake 1° x 2° NTMS area California and Nevada: data report, 5:23694 (GJBX—107(80))
YTTERBIUM/EXCHANGE INTERACTIONS
k dependence of the conduction-electron—local-moment exchange interaction in the atomic and covalent-mixing limits, 5:24402
YTTERBIUM 168/ENERGY LEVELS
Angular momentum fluctuation energy in the cranking model, 5:24949
YTTERBIUM 170/ENERGY LEVELS
Angular momentum fluctuation energy in the cranking model, 5:24949
YTTERBIUM 173 TARGET/MUON REACTIONS
Nuclear disintegration of some complex nuclei by 60-MeV muons, 5:24899
YTTRIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
YTTRIUM OXIDES/IONIC CONDUCTIVITY
High Na^+-ion conductivity in $Na_5YSi_4O_{12}$ (25 to 320°C, 3 kHz to 108 MHz), 5:24435
YTTRIUM OXIDES/SYNTHESIS
High Na^+-ion conductivity in $Na_5YSi_4O_{12}$ (25 to 320°C, 3 kHz to 108 MHz), 5:24435

Z

ZEA MAYS
See MAIZE
ZEOLITES/CONTAMINATION
Process for regenerating metal-contaminated hydrocarbon conversion catalysts (Patent), 5:23590
ZINC/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
ZINC/ACTIVATION ANALYSIS
Activation analysis, 5:24485
Instrumental analysis of trace elements in thumbnails of human subjects, 5:24484
ZINC/MATERIALS RECOVERY
A pollution-free system for the economic utilization of municipal solid waste, task 10, electrochemical recovery of non ferrous metals derived from municipal refuse, 5:24326 (PB—299753)
ZINC/METABOLISM
Metals in soft tissues of mule deer and antelope, 5:24775
ZINC/PLASTICITY
Influence of dislocation drag on twinning in zinc, 5:24403
ZINC/TWINNING
Influence of dislocation drag on twinning in zinc, 5:24403
ZINC CHLORIDES/BIOLOGICAL EFFECTS
Effects of divalent metal chlorides on respiration and extractable enzymatic activities of douglas-fir needle litter, 5:24769
ZINC PHOSPHIDES/EVAPORATION
Barrier heights of evaporated metal contacts on Zn_3P_2, 5:24474
ZINC TELLURIDES/CRYSTAL DEFECTS
Cathodoluminescence studies of anomalous ion implantation defect introduction in ZnTe, 5:24482
ZINC TELLURIDES/ION IMPLANTATION
Cathodoluminescence studies of anomalous ion implantation defect introduction in ZnTe, 5:24482
ZINC-CHLORINE BATTERIES/DESIGN
50 kW-hr zinc-chlorine hydrate battery, 5:24106
ZINC-CHLORINE BATTERIES/TESTING
50 kW-hr zinc-chlorine hydrate battery, 5:24106
ZIRCONIUM/ABSORPTION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
ZIRCONIUM/CATALYTIC EFFECTS
Catalyst for synthesis of methanol (Patent), 5:23774
ZIRCONIUM/EMISSION SPECTROSCOPY
Mesa NTMS 1° x 2° quadrangle area. Supplemental data report, 5:23682 (GJBX—81(80))
ZIRCONIUM/PHYSICAL RADIATION EFFECTS
Experimental observations of effects of inert gas on cavity formation during irradiation, 5:24423 (ORNL/TM—7193)
ZIRCONIUM OXIDES/CORROSION
Refractory materials for coal fueled mhd power generation. Final report, 5:24436 (PB—301095)
ZIRCONIUM OXIDES/FABRICATION
NASICON: a new solid electrolyte for Na/S batteries, 5:24158

CONTRACT NUMBER INDEX

Numbers assigned to DOE contracts under which reports announced in this publication were prepared are included in this index.

Contract No.	*Abstract No.*	*Report No.*
AC01-78ET10254	**Bituminous Coal Research, Inc., Monroeville, PA (USA)**	
	5:23418	DOE/ET/10254—T2
AC01-79CS30027	**Automation Industries, Inc., Richland, WA (USA). Vitro Engineering Div.**	
	5:23797	SOLAR/0010—80/04
	5:23941	SOLAR/2028—78/14
AC01-79CS40255	**Mitre Corp., McLean, VA (USA). METREK Div.**	
	5:24308	DOE/CS/40255—1
AC01-79EI10480	**Teknekron Research, Inc., Berkeley, CA (USA). Energy and Environmental Systems Div.**	
	5:24006	DOE/EIA/10480—T1
AC01-79ER10041	**PRC Energy Analysis Co., McLean, VA (USA)**	
	5:23865	DOE/ER—0049/1
AC01-79ET13152	**Oregon State Univ., Corvallis (USA). Dept. of Chemical Engineering**	
	5:23560	DOE/ET/13152—1
AC01-79ET14803	**Amoco Oil Co., Naperville, IL (USA). Research and Development Dept.**	
	5:23438	DOE/ET/14803—T4
AC01-79ET14941	**Battelle Columbus Labs., OH (USA)**	
	5:23451	BMI—2053
AC01-79ET15457	**General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.**	
	5:24011	DOE/ET/15457—10
	5:24015	DOE/ET/15457—4
AC02-79EV-10281	**Aspen Inst. for Humanistic Studies, Boulder, CO (USA)**	
	5:24664	CONF-800475—1
AC02-76CH00016	**Brookhaven National Lab., Upton, NY (USA)**	
	5:23803	BNL—27720
AC02-76CH03073	**Princeton Univ., NJ (USA). Plasma Physics Lab.**	
	5:24980	PPPL—1658
	5:25091	PPPL—1666
AC02-76ER01198	**Illinois Univ., Urbana (USA). Dept. of Chemical Engineering**	
	5:24499	DOE/ER/01198—1305
AC02-76ER01545	**Ohio State Univ., Columbus (USA). Dept. of Physics**	
	5:24867	DOE/ER/01545—274
AC02-76ER03244	**Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Physics**	
	5:24896	COO—3244-72
AC02-76ET37205	**Brigham Young Univ., Provo, UT (USA). Dept. of Chemical Engineering**	
	5:24089	COO—2571-19
	5:24091	DOE/ET/37205—T1
AC02-76ET52040	**Illinois Univ., Urbana (USA). Fusion Studies Lab.**	
	5:25011	COO—2218-160
AC02-76EV02472	**Harvard Univ., Cambridge, MA (USA). Museum of Comparative Zoology**	
	5:24667	DOE/EV/02472—6
AC02-76EV02874	**Stanford Univ., CA (USA). Dept. of Statistics**	
	5:24776	DOE/EV/02874—69
	5:25108	DOE/EV/02874—64
AC02-76EV03221	**Israel Inst. for Biological Research, Nes Ziona**	
	5:24504	DOE/EV/03221—66
	5:24670	DOE/EV/03221—65
	5:24733	DOE/EV/03221—61
	5:24734	DOE/EV/03221—62
	5:24735	DOE/EV/03221—63
	5:24744	DOE/EV/03221—64
AC02-76EV03490	**Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics**	
	5:24695	UR—3490-1559
	5:24736	UR—3490/LCP-20
	5:24771	UR—3490-1798
AC02-77CS40056	**United Merchants Research Center, Langley, SC (USA)**	
	5:24299	DOE/CS/40056—T1
AC02-77EV04159	**Sloan-Kettering Inst. for Cancer Research, New York (USA)**	
	5:24709	COO—4159-5
AC02-78CS40221	**Portland Cement Association, Skokie, IL (USA)**	
	5:24292	DOE/CS/40221—6
AC02-78ET21002	**Norske Veritas, Oslo**	
	5:23866	DOE/ET/21002—1
AC02-78EV04965	**Utah Univ., Salt Lake City (USA). Dept. of Meteorology**	
	5:24590	COO—4965-1
AC02-79ER10430	**Pennsylvania State Univ., University Park (USA)**	
	5:24386	DOE/ER/10430—1
AC02-79ER10460	**National Academy of Sciences, Washington, DC (USA)**	
	5:24804	DOE/ER/10460—1
AC02-79ER10471	**Illinois Inst. of Tech., Chicago (USA)**	
	5:24509	DOE/ER/10471—1
AC02-79ER10516	**Michigan State Univ., East Lansing (USA). Dept. of Physics**	
	5:24844	DOE/ER/10516—T2
	5:24871	DOE/ER/10516—T3
AC02-79ET15209	**General Electric Co., Philadelphia, PA (USA). Valley Forge Space Center**	
	5:24010	DOE/ET/15209—T1
AC02-79ET23004	**Rockwell International Corp., Anaheim, CA (USA). Electronic Devices Div.**	
	5:23804	COO—3004-2
AC02-79ET29187	**Franklin Inst. Research Labs., Philadelphia, PA (USA)**	
	5:23867	DOE/ET/29187—T3
AC02-79EV10281	**National Center for Atmospheric Research, Boulder, CO (USA)**	
	5:24589	CONF-800309—5
	5:24591	DOE/EV/10281—1
	5:24663	CONF-800474—1
AC02-EV02874	**Stanford Univ., CA (USA). Dept. of Statistics**	
	5:24751	DOE/EV/02874—68
AC03-76SF00515	**Stanford Linear Accelerator Center, CA (USA)**	
	5:24634	SLAC—228

Contract No.	Abstract No.	Report No.
AC03-78CS40167		Johns-Manville Sales Corp., Denver, CO (USA). Research and Development Center
	5:24307	DOE/CS/40167—T1
AC03-79CS40213		Beet Sugar Development Foundation, Fort Collins, CO (USA)
	5:23834	BSDF—39-2Q-80
AC03-79ET23033		Xerox Palo Alto Research Center, CA (USA)
	5:24457	DOE/ET/23033—16
AC03-79ET23040		Lockheed Palo Alto Research Labs., CA (USA)
	5:23807	DOE/ET/23040—4
AC03-79ET23045		Rockwell International Corp., Anaheim, CA (USA). Electronic Devices Div.
	5:23808	DOE/ET/23045—1
AC04-76DP0005		Mound Facility, Miamisburg, OH (USA)
	5:24581	MLM—2709(OP)
AC04-76DP00053		Mound Facility, Miamisburg, OH (USA)
	5:24413	MLM—2707(OP)
	5:24437	MLM—2711(OP)
	5:24580	MLM—2708(OP)
	5:24582	MLM—2710(OP)
AC04-76DP00613		Bendix Corp., Kansas City, MO (USA)
	5:24445	BDX—613-2399
AC04-76DP00656		General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.
	5:24494	GEPP-OP—474a
	5:24495	GEPP-OP—482
	5:24505	GEPP-OP—501
	5:24537	GEPP-FR—434
AC04-76DP00789		Sandia Labs., Albuquerque, NM (USA)
	5:23741	SAND—79-0278
	5:23742	SAND—79-1278
	5:23754	SAND—78-1331
	5:24429	SAND—80-0215
AC04-76DP03533		Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant
	5:24490	RFP—3090
	5:24646	RFP-ENV—79
AC04-79ET23010		Wayne State Univ., Detroit, MI (USA). Dept. of Chemistry
	5:23806	DOE/ET/23010—12
AC05-77CS02130		NAHB Research Foundation, Inc., Rockville, MD (USA)
	5:24252	DOE/CS/02130—T1
AC06-76ET53027		Mathematical Sciences Northwest, Inc., Bellevue, WA (USA)
	5:25025	MSNW—80-1144-1
AC06-77RL01030		Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations
	5:23714	RHO-CD—883
	5:23739	RHO-BWI-C—59
	5:23757	RHO-SA—165
AC07-76ID01570		Idaho National Engineering Lab., Idaho Falls (USA)
	5:24290	EGG—2027
AC07-76IDO1570		Idaho National Engineering Lab., Idaho Falls (USA)
	5:24078	CONF-800627—1
AC07-79ID01675		Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)
	5:23718	ENICO—1026
	5:23719	ENICO—1036
AC08-76DP01253		Nevada Univ., Las Vegas (USA). Desert Research Inst.
	5:24780	DOE/DP/01253—18
AC08-78DP40001		Acton Research Corp., MA (USA)
	5:24521	DOE/DP/40001—1
AC08-78DP400300		KMS Fusion, Inc., Ann Arbor, MI (USA)
	5:25073	KMSF-U—970
AC09-76SR00009		Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.
	5:24936	DP-MS—79-106
AC09-79ET47906		Nuclear Services Corp., Campbell, CA (USA)
	5:23706	DOE/ET/47906—4
AC09-79ET47921		Allied-General Nuclear Services, Barnwell, SC (USA)
	5:23705	AGNS—47921-TPR-3
AC09-DPSR00001		Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.
	5:23717	DP-MS—80-39
AC12-76SN00052		Knolls Atomic Power Lab., Schenectady, NY (USA)
	5:25110	KAPL—4134
AC13-76GJ01664		Geodata International, Inc., Dallas, TX (USA)
	5:23685	GJBX—95(80)
	5:23686	GJBX—96(80)(Vol.1)
	5:23687	GJBX—96(80)(Vol.2)
	5:23691	GJBX—101(80)
	5:23692	GJBX—104(80)
AC14-76FF02170		Hanford Engineering Development Lab., Richland, WA (USA)
	5:25090	HEDL-SA—1889-FP
AC15-76CL02395		Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.
	5:24054	CONF-800607—33
AC19-79BC10069		Illinois Inst. of Tech., Chicago (USA)
	5:23575	DOE/BC/10069—6
AC21-78MC03259		New Mexico State Univ., Las Cruces (USA). Dept. of Chemical Engineering
	5:23579	DOE/MC/03259—6
AC22-79PC20023		Pittsburgh Univ., PA (USA). Dept. of Civil Engineering
	5:23458	DOE/PC/20023—1
AI08-79DP40100		National Bureau of Standards, Washington, DC (USA)
	5:24522	DOE/DP/40100—1
AM01-79PE70106		Harvard Univ., Cambridge, MA (USA). Energy and Environmental Policy Center
	5:24255	DOE/PE/70106—T1
AS05-78ER06036		Texas A and M Univ., College Station (USA). Dept. of Chemistry
	5:24805	DOE/ER/06036—3
AS05-79ER10494		Maryland Univ., College Park (USA). Dept. of Chemistry
	5:24887	DOE/ER/10494—1
AS05-79ER10512		Tennessee Univ., Knoxville (USA). Dept. of Physics and Astronomy
	5:24819	DOE/ER/10512—T1
AS19-79BC20006		Rice Univ., Houston, TX (USA)
	5:23573	DOE/BC/20006—14
AS21-76MC05206		New York State Museum and Science Service, Albany (USA)
	5:23618	METC/EGSP—108
EC-77-A-31-1040		National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center
	5:24337	DOE/NASA/1040—80/14
EC-77-C-01-5085		Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab.
	5:24099	CONS—5085-T2
EC-77-C-03-1212		Miami Univ., Coral Gables, FL (USA)
	5:24357	SAN—1212-T1
EC-77-C-03-1701		Hittman Associates, Inc., Columbia, MD (USA)
	5:24319	SAN—1701-T1
EC-77-C-03-1732		Systems Control, Inc., Burlington, MA (USA)
	5:24298	DOE/CS/40021—1
EF-76-01-2215		Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.
	5:24215	FE—2215-13(Vol.1)
	5:24216	FE—2215-13(Vol.2)
EF-77-A-01-2593		Engelhard Minerals and Chemicals Corp., Edison, NJ (USA). Engelhard Industries Div.
	5:24338	DOE/NASA/9416—80/2
EF-77-A-01-2674		National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center
	5:24218	DOE/NASA/2674—80/9
	5:24222	DOE/NASA/2674—80/10
EF-77-C-01-1514		Westinghouse Electric Corp., Madison, PA (USA). Advanced Coal Conversion Dept.
	5:23421	FE—1514-97
EF-77-C-01-2012		Illinois Coal Gasification Group, Chicago (USA)
	5:23422	FE—2012-083
EF-77-C-01-2566		UOP, Inc., Des Plaines, IL (USA). Corporate Research Center
	5:23447	FE—2566-33
EF-77-C-01-2612		Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.
	5:24012	FE—2612-16
EF-77-C-01-2647		Thermo Electron Corp., Waltham, MA (USA)
	5:24336	TE—4234-37-80
EF-77-C-01-2709		Linhardt and Associates, Inc., Newport Beach, CA (USA)
	5:23412	FE—2709-T1

Contract No.	Abstract No.	Report No.
EF-77-C-01-2786	Westinghouse Electric Corp., Concordville, PA (USA). Combustion Turbine Systems Div.	
	5:24019	FE—2786-38
EF-77-C-03-1429	Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group	
	5:23429	SAN—1429-52
EF-77-G-01-2696	Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)	
	5:23448	FE—2696-T4
EF-77-S-01-2729	Brigham Young Univ., Provo, UT (USA)	
	5:23425	FE—2729-8
EF-77-S-01-2762	Princeton Univ., NJ (USA). Dept. of Mechanical and Aerospace Engineering	
	5:23426	FE—2762-7
EG-77-01-4042	Solar Energy Research Inst., Golden, CO (USA)	
	5:23818	DSE—4042-T30
EG-77-A-29-1078	Lockheed Missiles and Space Co., Sunnyvale, CA (USA). Ocean Systems Div.	
	5:23868	DOE/NOAA/OTEC—29(Summ.)
EG-77-C-01-4008	Spectro-Systems, Inc., Springfield, VA (USA)	
	5:23996	DGE—4008-F
EG-77-C-01-4042	Solar Energy Research Inst., Golden, CO (USA)	
	5:23775	DOE/CS/4042—T36
	5:23776	SERI/TR—352-554
	5:23799	SERI/TR—434-484
	5:23816	DOE/SERI—8119-3/1
	5:23817	DSE—4042-T17
	5:23821	SERI/TP—331-541
	5:23844	SERI/TP—623-656
	5:23853	SERI/TR—352-298
	5:23860	SERI/TP—641-653
	5:23878	CONF-790758—(Vol.II)
	5:23905	SERI/TP—333-429
	5:23959	SERI/TP—334-478
	5:23960	SERI/TP—334-565
	5:23961	SERI/TP—641-619
	5:23962	SERI/TR—8052-1
	5:24003	SERI/TP—731-649
EG-77-C-04-4150	Owens-Illinois, Inc., Toledo, OH (USA). Solar Energy Products Group	
	5:23949	ALO—4150-12
EG-77-G-04-4123	Total Environmental Action, Inc., Harrisville, NH (USA)	
	5:23946	ALO—4123-T1
	5:23947	ALO—4123-T2
	5:23948	ALO—4123-T3
EG-77-S-02-4433	Northwestern Univ., Evanston, IL (USA). Dept. of Mechanical and Nuclear Engineering	
	5:24022	COO—4433-3
EG-77-S-04-3977	New Mexico Univ., Albuquerque (USA). Dept. of Physics and Astronomy	
	5:23945	ALO—3977-5
EG-77-S-09-1015	Georgia Univ., Athens (USA). School of Forest Resources	
	5:23838	SRO—1015-T1
EI-78-C-01-6242	Systemetrics, Inc., Blacksburg, VA (USA)	
	5:24211	DOE/TIC—11177
EM-76-F-01-8154	Energy Development Board of Mercer County, Stanton, ND (USA)	
	5:24177	CONF-791178—
EM-77-F-01-8138	Illinois Commerce Commission, Springfield (USA)	
	5:24210	CONS—8138-T1
EM-78-C-02-4929	Portland Cement Association, Skokie, IL (USA)	
	5:24291	COO—4929-5
EM-78-C-02-4975	Detroit Edison Co., MI (USA)	
	5:24322	COO—4975-(Vol.1)(Text)
	5:24325	COO—4975-1(Vol.2)(App.)
EM-78-C-02-4980	Minnesota Energy Agency, St. Paul (USA)	
	5:24323	COO—4980-1
	5:24324	COO—4980-1(Exec.Summ.)
EM-78-C-03-1697	Energy and Environmental Analysis, Inc., Arlington, VA (USA)	
	5:24191	DOE/CS/1697—01
EM-78-C-03-2184	Escher Technology Associates, St. Johns, MI (USA)	
	5:24340	ATR—79(7759)-1(Vol.3)
	5:24341	ATR—79(7759)-(Vol.2)
EM-78-I-01-4209	Jet Propulsion Lab., Pasadena, CA (USA)	
	5:24342	CONS—4209-T1(Vol.10)
	5:24349	CONS—4209-T1(Vol.5)
EM-78-S-02-4930	Lehigh Univ., Bethlehem, PA (USA)	
	5:24297	COO—4930-1
EN-77-C-02-4325	Consolidated Edison Co. of New York, Inc., New York (USA)	
	5:24046	COO—4325-02
EN-77-S-02-4261	Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering	
	5:24090	COO—4261-14
EP-78-C-02-4651	Montana Energy and MHD Research and Development Inst., Inc., Butte (USA)	
	5:24214	DOE/EV/04651—T1
ES-77-A-01-6021	Naval Research Lab., Washington, DC (USA)	
	5:25014	NRL-MR—4241
	5:25074	NRL-MR—4212
ET-77-C-01-9145	Bituminous Coal Research, Inc., Monroeville, PA (USA)	
	5:23540	FE—9145-1
ET-78-C-01-3125	Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group	
	5:23427	FE—3125-15
ET-78-C-01-3134	Mitre Corp., McLean, VA (USA). METREK Div.	
	5:23536	FE—3134-1
	5:23537	FE—3134-2
ET-78-C-01-3137	Bechtel National, Inc., San Francisco, CA (USA)	
	5:23449	FE—3137-T1
ET-78-C-01-3162	Daedalean Associates, Inc., Woodbine, MD (USA)	
	5:24023	FE—3162-T1
ET-78-C-01-3242	General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.	
	5:24034	FE—3242-11
ET-78-C-01-3269	Stone and Webster Engineering Corp., New York (USA)	
	5:23459	FE—3269-11A
ET-78-C-02-4881	Prototech Co., Newton Highlands, MA (USA)	
	5:24498	COO—4881-3
ET-78-C-02-5022	Gilbert Associates, Inc., Reading, PA (USA)	
	5:23835	DOE/ET/20611—12
ET-78-C-03-1866	ENSCI, Inc., College Park, MD (USA)	
	5:24510	DOE/ET/12438—T1
ET-78-C-03-2192	Bechtel National, Inc., San Francisco, CA (USA)	
	5:23851	SAN—2192-T1
ET-78-S-01-3288	Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)	
	5:24335	CONS—3288-T6
ET-78-S-04-5450	California Univ., Los Angeles (USA). Dept. of Chemical, Nuclear, and Thermal Engineering	
	5:24080	ALO—81
	5:24662	ALO—80
EW-78-A-21-8450	Physical Sciences, Inc., Woburn, MA (USA)	
	5:23428	METC—8450-T1
EW-78-C-21-8333	Science Applications, Inc., McLean, VA (USA)	
	5:24543	SAI—129-79-PGH
EW-78-C-22-0208	Carnegie-Mellon Univ., Pittsburgh, PA (USA)	
	5:23420	FE—0208-T1
EX-76-A-29-1010	General Electric Co., Philadelphia, PA (USA). Space Div.	
	5:24005	DOE/NASA/0058—79/2(Vol.1)
EX-76-A-29-1020	PRC Energy Analysis Co., McLean, VA (USA)	
	5:23878	CONF-790758—(Vol.II)
EX-76-A-29-1024	Interactive Resources, Inc., Point Richmond, CA (USA)	
	5:23904	DOE/NASA/CR—161414
EX-76-A-29-1028	Paragon Pacific, Inc., El Segundo, CA (USA)	
	5:24004	DOE/NASA/0026—79/1
EX-76-A-34-1006	Naval Research Lab., Washington, DC (USA)	
	5:24563	NRL-MR—4171
	5:25002	NRL-MR—4177
EX-76-A-36-1008	Johns Hopkins Univ., Baltimore, MD (USA). Center for Metropolitan Planning and Research	
	5:23998	DOE/ET/27025—T1
EX-76-C-01-1517	Fluor Engineers and Constructors, Inc., Irvine, CA (USA)	
	5:23440	FE—1517-89
	5:23441	FE—1517-90
	5:23442	FE—1517-91
	5:23443	FE—1517-92

Contract No.	Abstract No.	Report No.
EX-76-C-01-1726	Dorr-Oliver, Inc., Stamford, CT (USA)	
	5:23561	FE—1726-34A
EX-76-C-01-1765	General Electric Co., Schenectady, NY (USA). Gas Turbine Div.	
	5:24017	FE—1765-44
EX-76-C-01-1806	General Electric Co., Schenectady, NY (USA). Gas Turbine Div.	
	5:24018	FE—1806-86
EX-76-C-01-2006	Utah Univ., Salt Lake City (USA). Dept. of Mining and Fuels Engineering	
	5:23444	FE—2006-17
EX-76-C-01-2030	Pennsylvania State Univ., University Park (USA). Coal Research Section	
	5:23454	FE—2030-TR18
	5:23455	FE—2030-TR20
	5:23456	FE—2030-TR21
EX-76-C-01-2044	Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group	
	5:23445	FE—2044-51
EX-76-C-01-2248	Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.	
	5:24221	FE—2248-23
EX-76-C-01-2304	Encotech, Inc., Schenectady, NY (USA)	
	5:23562	FE—2304-43
EX-76-C-01-2315	Chevron Research Co., Richmond, CA (USA)	
	5:23446	FE—2315-45
EX-76-C-01-2338	Lehigh Univ., Bethlehem, PA (USA)	
	5:23423	FE—2338-14
EX-76-C-01-2346	Dow Chemical Co., Midland, MI (USA)	
	5:23626	FE—2346-48
	5:23627	FE—2346-58
	5:23628	FE—2346-64
	5:23643	FE—2346-37
EX-76-C-01-2381	Interactive Resources, Inc., Point Richmond, CA (USA)	
	5:23904	DOE/NASA/CR—161414
EX-76-C-01-2469	Institute of Gas Technology, Chicago, IL (USA)	
	5:23424	FE—2469-48
EX-77-A-29-1060	Jet Propulsion Lab., Pasadena, CA (USA)	
	5:23859	DOE/JPL—1060-31
EY-76-A-08-0539	Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring Systems Lab.	
	5:24630	EMSL-LV—0539-36
	5:24641	EMSL-LV—0539-33
EY-76-C-02-0016	Brookhaven National Lab., Upton, NY (USA)	
	5:23452	BNL—27607
	5:23758	BNL—27663
	5:23862	BNL—27710
	5:23875	BNL—27662
	5:23876	BNL—27667
	5:23877	BNL—27711
	5:24073	BNL-NUREG—27192
	5:24200	BNL—27613
	5:24201	BNL—27721
	5:24234	BNL—27452
	5:24248	BNL—27602
	5:24487	BNL—27611
	5:24556	BNL—27654
	5:24557	BNL—27678
	5:24650	BNL—27406
	5:24861	BNL—27615
	5:24875	BNL—27617
	5:25104	BNL—27513
	5:25105	BNL—27665
EY-76-C-02-2608	Corning Museum of Glass, NY (USA)	
	5:23950	COO—2608-3
EY-76-C-02-2975	General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.	
	5:24049	COO—2975-40
EY-76-C-02-3069	Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Nuclear Science	
	5:24835	DOE/ER/03069—770
EY-76-C-02-3073	Princeton Univ., NJ (USA). Plasma Physics Lab.	
	5:24994	PPPL—1664
	5:25003	PPPL—1662
	5:25017	PPPL—1659
	5:25026	PPPL—1663
EY-76-C-02-3075	Yale Univ., New Haven, CT (USA). Dept. of Physics	
	5:24876	COO—3075-224
EY-76-C-02-4049	Management and Technical Services Co., Philadelphia, PA (USA)	
	5:24217	COO—4049-16
EY-76-C-02-4094	Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.	
	5:23805	COO—4094-64
EY-76-C-03-0115-097	SRI International, Menlo Park, CA (USA). Poulter Lab.	
	5:24096	SAN—0115-T7
EY-76-C-03-0189-061	General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.	
	5:24055	CRBRP-GEFR-SP—176
EY-76-C-03-1176	Stanford Research Inst., Menlo Park, CA (USA)	
	5:24267	SAN—1176-T1(Vol.1)
	5:24268	SAN—1176-T1(Vol.2)
	5:24269	SAN—1176-T1(Vol.3)
	5:24270	SAN—1176-T1(Vol.4)
	5:24271	SAN—1176-T3
EY-76-C-03-1207	Biphase Energy Systems, Santa Monica, CA (USA)	
	5:24309	DOE/ET/15350—T1
EY-76-C-04-0053	Mound Facility, Miamisburg, OH (USA)	
	5:23953	MLM—2702(OP)
EY-76-C-04-0613	Bendix Corp., Kansas City, MO (USA)	
	5:24508	BDX—613-2375
EY-76-C-04-0789	Sandia National Labs., Albuquerque, NM (USA)	
	5:23538	SAND—80-0537
	5:23620	SAND—80-1134
	5:23743	SAND—80-0359C
	5:23744	SAND—80-0502C
	5:23745	SAND—80-1020/1
	5:23746	SAND—80-1020/1
	5:23820	SAND—80-0926C
	5:23852	SAND—80-0873C
	5:23858	SAND—80-8203
	5:23892	SAND—78-8176
	5:23954	SAND—79-2371C
	5:24042	ALO—75
	5:24044	SAND—80-0670
	5:24072	ALO—63
	5:24080	ALO—81
	5:24082	ALO—66
	5:24097	SAND—80-0888C
	5:24331	SAND—80-0989C
	5:24414	SAND—80-8215
	5:24430	SAND—80-0427C
	5:24458	SAND—80-8502
	5:24519	SAND—79-1424
	5:24570	SAND—80-0029C
	5:24571	SAND—80-0408C
	5:24583	SAND—80-0355C
	5:24662	ALO—80
	5:25004	SAND—79-2338C
	5:25075	SAND—80-0402
	5:25092	SAND—79-2105C
	5:25093	SAND—79-2409C
	5:25112	SAND—80-0438C
EY-76-C-05-0033	Oak Ridge Associated Universities, Inc., TN (USA)	
	5:24332	DOE/IR/0033—T2
	5:24333	DOE/OR/00033—T1
EY-76-C-06-1830	Battelle Pacific Northwest Labs., Richland, WA (USA)	
	5:23702	PNL—3166(Pt.1)
	5:23703	PNL-SA—7844
	5:23709	PNL—3171
	5:23732	ONWI—85
	5:23735	PNL—2859
	5:23736	PNL—2862
	5:23737	PNL—2874
	5:23738	PNL—3318
	5:23891	PNL-SA—7820
	5:24060	PNL-TR—398
	5:24061	PNL-TR—393
	5:24079	PNL-TR—397
	5:24182	PNL—2410(Rev.2)
	5:24668	PNL—3081
	5:24754	PNL—3209
EY-76-C-06-2325	Flow Industries, Inc., Kent, WA (USA)	
	5:23997	RLO—2325
EY-76-C-07-1570	Idaho National Engineering Lab., Idaho Falls (USA)	
	5:24081	

Contract No.	Abstract No.	Report No.
		EGG/LTR-LO—0080-113
	5:24087	CONF-800536—1
	5:24088	CONF-800607—15
	5:24092	EGG-FM—5078
	5:24565	DOE/ID/01570—T4
	5:25109	EGG—2015
EY-76-C-09-0001	Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.	
	5:23716	DP—1540
	5:24629	DPSPU—80-30-1
EY-76-C-13-1664	Arizona Univ., Tucson (USA). Dept. of Mining and Geological Engineering	
	5:23673	GJBX—112(80)
	5:23675	GJBX—51(80)
	5:23676	GJBX—54(80)
	5:23677	GJBX—73(80)(Vol.1)
	5:23678	GJBX—73(80)(Vol.2)
	5:23679	GJBX—79(80)(Vol.1)
	5:23680	GJBX—79(80)(Vol.2)
	5:23681	GJBX—80-(80)(Vol.1)
	5:23682	GJBX—81(80)
	5:23683	GJBX—91(80)
	5:23684	GJBX—92(80)
	5:23688	GJBX—97(80)
	5:23689	GJBX—99(80)
	5:23690	GJBX—100(80)
	5:23693	GJBX—106(80)
	5:23694	GJBX—107(80)
	5:23695	GJBX—108(80)
EY-76-C-14-2170	Hanford Engineering Development Lab., Richland, WA (USA)	
	5:24093	HEDL-TME—75-85
	5:24421	HEDL-SA—1774-FP
EY-76-C-15-0003	Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.	
	5:24054	CONF-800607—33
EY-76-S-02-2856	Indiana Univ., Bloomington (USA). Dept. of Chemistry	
	5:23453	DOE/EV/2856—5
EY-76-S-02-3382	New York Univ., NY (USA). Inst. of Environmental Medicine	
	5:24755	COO—3382-18
EY-76-S-03-0034-255	California Univ., Berkeley (USA). Sea Water Conversion Lab.	
	5:23869	DSE—0034-T1
EY-76-S-05-3027	Georgia Inst. of Tech., Atlanta (USA). School of Electrical Engineering	
	5:24820	ORO—3027-52
EY-76-S-05-4908	Burt, Hill, Kosar, Rittlemann, and Associates, Butler, PA (USA)	
	5:23879	DOE/CS—T0145
EY-76-S-05-4946	Tennessee Univ., Knoxville (USA). Dept. of Civil Engineering	
	5:23518	ORO—4946-T1
EY-76-S-05-5099	Georgia Inst. of Tech., Atlanta (USA). Engineering Experiment Station	
	5:24300	ORO—5099-T2
EY-76-S-06-2225-046	Washington Univ., Seattle (USA). Dept. of Nuclear Engineering	
	5:23766	UWFPP—6
	5:25078	UWFPP—7
EY-77-C-02-4596	Radian Corp., Austin, TX (USA)	
	5:25107	COO—4596-1(Vol.3)
EY-77-C-03-1731	Varigas Research, Inc., Timonium, MD (USA)	
	5:24303	SAN—1731-T3
EY-77-C-05-5366	Kaiser Engineers, Oakland, CA (USA)	
	5:23734	ORO—5366-T2
EY-77-C-06-1030	Rockwell International Corp., Richland, WA (USA). Energy Systems Group	
	5:23740	RHO-SA—155
FC07-79ID12019	Nevada Dept. of Energy, Carson City (USA)	
	5:23990	DOE/ID/12019—1
FC20-78LC10787	Geokinetics, Inc., Concord, CA (USA)	
	5:23625	DOE/LETC/10787—44
FG04-77CS34154	Earth Integral of Living Systems, Winters, CA (USA)	
	5:23880	DOE/CS/34154—1
	5:23881	DOE/CS/34154—2-3
FG04-77CS34163	Solar Energy Technology, Inc., Bedford, MA (USA)	
	5:23951	DOE/CS/34163—2
FY-76-C-03-0893-010	General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.	
	5:24056	GEFR-SP—196
NAS-7-100-954331	Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center	
	5:23809	DOE/JPL/954331—80/9
	5:23810	DOE/JPL/954331—80/9(Vol.2)
NAS-7-100-954853	Spectrolab, Inc., Sylmar, CA (USA)	
	5:23811	DOE/JPL/954853—80/9
NAS-7-100-955077	Solarex Corp., Rockville, MD (USA)	
	5:23812	DOE/JPL/955077—79
NAS-7-100-955089	Optical Coating Lab., Inc., City of Industry, CA (USA). Photoelectronics Div.	
	5:23813	DOE/JPL/955089—80/6
NAS-7-100-955342	RCA Solid State Div., Somerville, NJ (USA)	
	5:23814	DOE/JPL/955342—4
NAS-7-100-955533	Hemlock Semiconductor Corp., MI (USA)	
	5:23815	DOE/JPL/955533—79/1
W-31-109-ENG-38	Argonne National Lab., IL (USA)	
	5:23417	ANL—80-12
	5:23558	ANL/CEN/FE—80-1
	5:23564	ANL/EES-TM—84
	5:23797	SOLAR/0010—80/04
	5:23798	DOE/ER—0050
	5:23832	ANL/ES—91
	5:23846	DOE-ER—0052
	5:23847	DOE/ER—0053
	5:23848	DOE/ER—0054
	5:23849	DOE/ER—0055
	5:23850	DOE/ER—0056
	5:24051	ANL—79-57
	5:24052	ANL—80-31
	5:24103	ANL—80-32
	5:24155	ANL—80-16
	5:24156	ANL—80-30
	5:24232	ANL—79-84
	5:24233	ANL—79-110
	5:24243	ANL/EES-TM—81
	5:24385	ANL-CT—79-19
	5:24507	ANL/MSD/FE—80-2
	5:24551	ACC—6
	5:24588	ANL/EES-TM—83
	5:24952	ANL—80-27
	5:24974	ANL—80-39
W-7405-ENG-26	Oak Ridge National Lab., TN (USA)	
	5:23533	CONF-790949—3
	5:23559	CONF-800545—1
	5:23572	CONF-791241—1
	5:23671	CONF-791185—3
	5:23715	CONF-791112—63
	5:23722	ORNL/TM—7371
	5:23733	ORNL/SUB—80/13619/1
	5:23756	CONF-791203—9
	5:23759	CONF-790707—36
	5:23983	CONF-7910155—1
	5:23989	CONF-800517—4
	5:24024	CONF-800543—2
	5:24025	CONF-800543—3
	5:24026	CONF-800543—4
	5:24036	ORNL—5657
	5:24045	CONF-791118—11
	5:24050	ORNL/TM—7209
	5:24053	CONF-791205—23
	5:24059	ORNL/TM—7246
	5:24069	ORNL/TM—7150
	5:24070	CONF-791051—23
	5:24071	CONF-791186—1
	5:24083	CONF-791049—26
	5:24084	CONF-791058—71
	5:24085	CONF-791118—10
	5:24086	CONF-800434—2
	5:24095	ORNL/TM—7211
	5:24100	CONF-791108—24
	5:24101	CONF-7910152—1
	5:24122	CONF-781063—7
	5:24175	ORNL—5636
	5:24187	CONF-791103—110
	5:24189	CONF-7910156—2
	5:24193	CONF-800403—43
	5:24194	CONF-7910153—1
	5:24244	ORNL—5552
	5:24245	ORNL/Sub—78/97726/1
	5:24246	ORNL/Sub—7470/1-V2
	5:24249	

Contract No.	Abstract No.	Report No.
		CONF-791242—2
	5:24250	CONF-800524—2
	5:24305	CONF-800548—1
	5:24306	CONF-800549—1
	5:24368	K/CSD/INF—79/27
	5:24374	CONF-791112—62
	5:24375	ORNL/TM—7247
	5:24393	CONF-791112—65
	5:24394	CONF-791132—5
W-7405-ENG-26	**Oak Ridge National Lab., TN (USA)**	
	5:24420	DOE/TIC—11202
W-7405-ENG-26	**Oak Ridge National Lab., TN (USA)**	
	5:24423	ORNL/TM—7193
	5:24488	CONF-791103—111
	5:24491	Y—2205
	5:24513	CONF-791102—169
	5:24518	K/P—6567
	5:24552	CONF-790976—10
	5:24559	CONF-791117—26
	5:24560	CONF-790859—3
	5:24561	CONF-7910149—1
	5:24592	DOE/TIC—11203
	5:24628	CONF-791103—107
	5:24632	ORNL—5634
	5:24633	ORNL/TM—6874
	5:24642	CONF-7910141—1
	5:24643	CONF-791090—7
	5:24651	CONF-791059—8
	5:24654	UCID—18652
	5:24702	CONF-7810136—2
	5:24762	CONF-791059—6
	5:24763	CONF-7910146—1
	5:24765	CONF-790663—3
	5:24785	UCRL—15221
	5:24886	CONF-791243—1
	5:24901	CONF-7910148—1
	5:24930	CONF-790976—9
	5:24953	CONF-7810133—6
	5:24992	CONF-791058—72
	5:24993	CONF-800138—1
	5:25010	CONF-791057—4
	5:25015	ORNL/CSD/TM—109
	5:25016	ORNL/TM—7302
	5:25044	CONF-791102—163
	5:25047	CONF-791102—164
	5:25048	CONF-791102—167
	5:25052	CONF-791102—166
	5:25062	CONF-791102—168
	5:25063	CONF-791102—161
	5:25084	CONF-791058—74
	5:25085	CONF-791058—75
	5:25086	CONF-791102—165
	5:25087	CONF-791102—171
	5:25088	CONF-800455—8
	5:25111	ORNL/TM—7265
	5:25116	ORNL/TM—7294
W-7405-ENG-36	**Los Alamos Scientific Lab., NM (USA)**	
	5:23541	LA-UR—80-551
	5:23601	LA—8347-MS
	5:23619	LA—8104-PR
	5:23696	LA—8321-PR
	5:23697	LA-UR—80-1013
	5:23720	LA-UR—80-1168
	5:23721	LA-UR—80-1265
	5:23729	LA—8177
	5:23884	LA-UR—80-693
	5:23885	LA-UR—80-1014
	5:23952	LA-UR—80-852
	5:23984	LA—8276-MAP
	5:23986	LA—8326-MS
	5:23987	LA—8252-MS
	5:23988	LA-UR—80-670
	5:24041	LA—8323-PR
	5:24047	LA—8041-MS(Rev)
	5:24057	LA-UR—80-1159
	5:24058	LA-UR—80-1283
	5:24094	LA-UR—80-1069
	5:24395	LA-UR—80-1252
	5:24422	LA—8351-MS
	5:24486	LA—8145
	5:24489	LA-UR—80-1215
	5:24511	

Contract No.	Abstract No.	Report No.
		DOE/TIC—11192
	5:24553	LA—8293-PR
	5:24554	LA—8356-MS
	5:24647	LA—8221
	5:24796	LA—8344-T
	5:24801	LA-UR—80-1199
	5:24839	LA-tr—80-12
	5:24863	LA-tr—80-11
	5:24890	LA—8087
	5:24955	LA-UR—80-1005
	5:24969	LA—8320-PR
	5:24970	LA—8310-MS
	5:24978	LA—8226-MS
	5:24979	LA—8325-MS
	5:25013	LA-UR—80-1109
	5:25024	LA—8340-MS
	5:25049	LA-UR—80-1104
	5:25066	LA-UR—79-2971
	5:25067	LA-UR—80-1203
	5:25068	LA-UR—80-1249
	5:25069	LA-UR—80-1273
W-7405-ENG-48	**California Univ., Livermore (USA). Lawrence Livermore Lab.**	
	5:23612	UCRL—15224
	5:23639	UCID—18618
	5:23710	UCID—18660
	5:23730	LBL—10387
	5:23731	LBL—10483
	5:23747	UCID—18651
	5:23748	UCID—18664
	5:23749	UCID—18665
	5:23750	UCRL—15228
	5:23751	UCRL—15229
	5:23752	UCRL—15232
	5:23760	UCRL—82530
	5:23765	UCRL—83928
	5:23836	LBL—10667
	5:23886	LBL—10034
	5:23887	LBL—10770
	5:23888	LBL—10771
	5:23979	LBL—10615
	5:23993	DOE/EV—0068
	5:23995	UCRL—15094
	5:23999	LBL—10848
	5:24048	UCRL—52902
	5:24186	UCRL—15226
	5:24209	UCID—18621
	5:24293	LBL—10520
	5:24348	UCRL—15241
	5:24369	LBL—10259
	5:24371	UCRL-Trans—11542
	5:24517	UCRL—84327
	5:24538	UCID—18626
	5:24549	UCRL-Trans—1592
	5:24555	LBL-PUB—300
	5:24572	UCID—18622
	5:24573	UCRL—84295
	5:24584	UCRL—83727
	5:24631	LBL—9814
	5:24635	UCRL—83583
	5:24770	UCRL—52932
	5:24782	UCRL—52909
	5:24784	UCRL—15220
	5:24791	UCRL—15234
	5:24846	LBL—10801
	5:24927	UCRL—84370
	5:24939	LBL—10645
	5:24971	LBL—10172
	5:24981	UCID—18334
	5:24982	UCID—18623
	5:24983	UCRL—84270
	5:24995	UCRL—83805
	5:25005	UCRL—52923
	5:25006	UCRL—84221
	5:25018	UCRL—84044(Rev.1)
	5:25045	UCRL—84245
	5:25050	UCID—18614
	5:25051	UCID—18615
	5:25064	UCRL—84018
	5:25076	UCID—18588
	5:25077	UCRL—81919
	5:25113	UCID—18620
W-7405-ENG-92	**Battelle Columbus Labs., OH (USA)**	
	5:23833	BMI—2031(Vol.3)

REPORT NUMBER INDEX

The numbers assigned to all reports cited in the publication appear in the first column of the index. The citation numbers are included in the second column. Cross reference information and/or availability are included as appropriate. Abbreviations used in the availability column are elaborated at the end of the index.

Report No.	*Abstract No.*	*Availability*
ACC-		
6	5:24551	NTIS, PC A03/MF A01
AFATL-TR-		
79-101	5:24647	*See* LA-8221
AGNS-		
47921-TPR-3	5:23705	NTIS, PC A02/MF A01
ALO-		
63	5:24072	Dep. NTIS, PC A06/MF A01
65	5:24044	*See* SAND-80-0670
66	5:24082	NTIS, PC A05/MF A01
75	5:24042	Dep. NTIS, PC A04/MF A01
80	5:24662	NTIS, PC A02/MF A01
81	5:24080	NTIS, PC A03/MF A01
3977-5	5:23945	Dep. NTIS, PC A06/MF A01
4123-T1	5:23946	NTIS, PC A03/MF A01
4123-T2	5:23947	NTIS, PC A04/MF A01
4123-T3	5:23948	NTIS, PC A06/MF A01
4150-12	5:23949	NTIS, PC A04/MF A01
ANL-		
79-57	5:24051	NTIS, PC A05/MF A01
79-84	5:24232	NTIS, PC A03/MF A01
79-110	5:24233	NTIS, PC A03/MF A01
80-12	5:23417	Dep. NTIS, PC A05/MF A01
80-16	5:24155	NTIS, PC A07/MF A01
80-27	5:24952	NTIS, PC A04/MF A01
80-30	5:24156	NTIS, PC A04/MF A01
80-31	5:24052	NTIS, PC A03/MF A01
80-32	5:24103	NTIS, PC A03/MF A01
80-39	5:24974	NTIS, PC A05/MF A01
ANL/CEN/FE-		
80-1	5:23558	Dep. NTIS, PC A02/MF A01
ANL-CT-		
79-19	5:24385	NTIS, PC A06/MF A01
ANL/EES-TM-		
81	5:24243	NTIS, PC A02/MF A01
83	5:24588	Dep. NTIS, PC A03/MF A01
84	5:23564	Dep. NTIS, PC A06/MF A01
ANL/ES-		
91	5:23832	NTIS, PC A07/MF A01
ANL/MSD/FE-		
80-2	5:24507	NTIS, PC A02/MF A01
ATR-		
79(7759)-1(Vol.3)	5:24340	Dep. NTIS, PC A10/MF A01
79(7759)-(Vol.2)	5:24341	Dep. NTIS, PC A15/MF A01
BCR-L-		
923	5:23540	*See* FE-9145-1
BDX-		
613-2375	5:24508	Dep. NTIS, PC A02/MF A01
613-2399	5:24445	NTIS, PC A02/MF A01
BMI-		
2031(Vol.3)	5:23833	Dep. NTIS, PC A03/MF A01
2053	5:23451	Dep. NTIS, PC A03/MF A01
BNL-		
27406	5:24650	NTIS, PC A04/MF A01
27452	5:24234	NTIS, PC A03/MF A01
27513	5:25104	Dep. NTIS, PC A02/MF A01
27602	5:24248	NTIS, PC A02/MF A01
27607	5:23452	NTIS, PC A02/MF A01
27611	5:24487	NTIS, PC A02/MF A01
27613	5:24200	NTIS, PC A03/MF A01
27615	5:24861	NTIS, PC A02/MF A01
27617	5:24875	NTIS, PC A03/MF A01
27654	5:24556	NTIS, PC A02/MF A01
27662	5:23875	NTIS, PC A02/MF A01
27663	5:23758	NTIS, PC A02/MF A01
27665	5:25105	NTIS, PC A04/MF A01
27667	5:23876	NTIS, PC A02/MF A01
27678	5:24557	NTIS, PC A10/MF A01
27710	5:23862	NTIS, PC A02/MF A01
27711	5:23877	NTIS, PC A02/MF A01
27720	5:23803	NTIS, PC A02/MF A01
27721	5:24201	NTIS, PC A02/MF A01
BNL-NUREG-		
27192	5:24073	Dep. NTIS, PC A02/MF A01
BSDF-		
39-2Q-80	5:23834	NTIS, PC A02/MF A01
CEP-OP-		
0-2	5:24192	Council on Economic Priorities, 84 Fifth Ave., New York, NY
CONF-7706194-		(Rocky Mountain Energy Economics Institute meeting, Aspen, CO, USA, 26-29 Jun 1977)
	5:24199	Boulder, CO; Westview Press, Inc. (1978).
CONF-7706195-		(Symposium of the committee on gas of the Economic Commission for Europe, Minsk, Byelorussian, USSR, 20-27 Jun 1977)
	5:23613	Elmsford, NY; Pergamon Press, Inc. (1978).
CONF-770776-		(Forest products research society annual meeting, Denver, CO, USA, 7 Jul 1977)
	5:24320	Madison, WI; Forest Products Research Society (1978).
CONF-771028-		(Conference on electrical insulation and dielectric phenomena, Schenectady, NY, USA, 17-20 Oct 1977)
	5:24074	*See* EPRI-EL-1263
	5:24075	*See* EPRI-EL-1263
	5:24440	*See* EPRI-EL-1263
	5:24441	*See* EPRI-EL-1263
	5:24442	*See* EPRI-EL-1263
	5:24446	*See* EPRI-EL-1263
	5:24447	*See* EPRI-EL-1263
	5:24448	*See* EPRI-EL-1263
	5:24449	*See* EPRI-EL-1263
	5:24450	*See* EPRI-EL-1263
	5:24451	*See* EPRI-EL-1263
	5:24452	*See* EPRI-EL-1263
	5:24531	*See* EPRI-EL-1263
CONF-7803123-		(Uranium resource/technology update - front end of the nuclear fuel cycle, Golden, CO, USA, 14 Mar 1978)
	5:23711	Golden, CO; Colorao School of Mines (1978).
CONF-780407-		(Symposium on design, construction and operating experience of demonstration liquid metal fast breeder reactors, Bologna, Italy, 10-14 Apr 1978)
10	5:24079	*See* PNL-TR-397

Report No.	Abstract No.	Availability
11	5:24061	*See* PNL-TR-393
CONF-780460-	(11. oil shale symposium, Golden, CO, USA, 11-14 Apr 1978)	
	5:23616	$12.00
CONF-780624-	(Power sources symposium, Atlantic City, NJ, USA, 12-15 Jun 1978)	
	5:24102	Princeton, NJ; Electrochemical Society, Incorporated (1978).
CONF-7806123-	(Symposium on critical issues in coal transportation systems, Washington, DC, USA, 14-15 Jun 1978)	
	5:23543	Washington, DC; National Academy of Sciences (1979).
CONF-781063-	(2. symposium on molten salts, Pittsburgh, PA, USA, 15-20 Oct 1978)	
7	5:24122	Dep. NTIS, PC A02/MF A01
CONF-7810133-	(12. annual symposium of the German Health Physics Society--radioactivity and the environment, Norderney, F.R. Germany, 2-6 Oct 1978)	
6	5:24953	NTIS, PC A02/MF A01
CONF-7810136-	(4. College Park colloquium on chemical evolution, limits of life, College Park, MD, USA, 18-20 Oct 1978)	
2	5:24702	Dep. NTIS, PC A03/MF A01
CONF-781202-	(ASME meeting, San Francisco, CA, USA, 10-15 Dec 1978)	
P1	5:23975	New York, NY; American Society of Mechanical Engineers (1978).
CONF-781247-	(2. international conference on energy storage, compression and switching, Venice, Italy, 5-8 Dec 1978)	
8	5:25077	*See* UCRL-81919
CONF-790172-	(Management assessment of energy from biomass and wastes conference, Orlando, FL, USA, 21-23 Jan 1979)	
	5:23839	Chicago, IL; Institute of Gas Technology (1980).
CONF-790175-	(International conference on energy and the environment, Bangalore, India, 11-13 Jan 1979)	
1	5:24200	*See* BNL-27613
CONF-790205-	(5. international ash utilization symposium, Atlanta, GA, USA, 25-27 Feb 1979)	
(Pt.1)	5:23413	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23457	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23460	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23461	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23462	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23463	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23464	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23465	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23466	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23467	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23468	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23469	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23470	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23471	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23472	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23473	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23474	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23475	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23476	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23477	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23478	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23479	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23480	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23481	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23542	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:23565	*See* METC/SP-79/10(Pt.1)
(Pt.1)	5:24035	*See* METC/SP-79/10(Pt.1)
(Pt.2)	5:23482	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23483	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23484	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23485	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23486	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23487	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23488	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23489	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23490	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23491	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23492	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23493	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23494	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23495	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23496	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23497	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23498	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23499	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23500	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23501	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23502	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23503	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23504	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23505	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23506	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23507	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23508	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23509	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23510	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23511	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23512	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23516	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:23517	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:24311	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:24312	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:24313	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:24314	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:24461	*See* METC/SP-79/10(Pt.2)
(Pt.2)	5:24462	*See* METC/SP-79/10(Pt.2)
CONF-790431-	(20. AESOP conference, Gatlinburg, TN, USA, 24 Apr 1979)	
(Summ.)	5:25106	NTIS, PC A03/MF A01
CONF-790440-	(12. oil shale symposium, Golden, CO, USA, 18-20 Apr 1979)	
	5:23615	Golden, CO; Colorado School of Mines (1979).
CONF-790599-	(Ammonia-from-coal symposium, Muscle Shoals, AL, USA, 8-10 May 1979)	
	5:23778	Tennessee Valley Authority, Office of Agricultural and Chemical Development, Muscle Shoals, AL
CONF-7905103-	(Energy technology conference on waste irradiation, Hanover, F.R. Germany, 2-4 May 1979)	
2	5:24331	*See* SAND-80-0989C
CONF-7905150-	(3. workshop on current problems in high energy particle theory, Florence, Italy, 30 May-1 Jun 1979)	
1	5:24876	*See* COO-3075-224
CONF-790631-	(6. OTEC conference, Washington, DC, USA, 19-22 Jun 1979)	
(Vol.1)	5:23863	Dep. NTIS, PC A23/MF A01
(Vol.2)	5:23864	Dep. NTIS, PC A19/MF A01
CONF-790663-	(Symposium on analysis of waters associated with alternate fuel production, Pittsburgh, PA, USA, 4-5 Jun 1979)	
3	5:24765	Dep. NTIS, PC A02/MF A01
CONF-7906147-	(1. annual Iowa solar operational results conference, Cedar Rapids, IA, USA, 21-22 Jun 1979)	
	5:23871	Des Moines, IA; Iowa Solar Office (1979).
CONF-790707-	(20. annual meeting of the Institute of Nuclear Materials Management, Albuquerque, NM, USA, 16-19 Jul 1979)	
36	5:23759	NTIS, PC A02/MF A01
CONF-790758-	(DOE regional solar update conference, Dearborn, MI, USA, 11-13 Jul 1979)	
(Vol.II)	5:23878	Dep. NTIS, PC A14/MF A01
CONF-790802-	(International conference on structural mechanics in reactor technology, Berlin, F.R. Germany, 13-17 Aug 1979)	
79	5:24421	*See* HEDL-SA-1774-FP
CONF-790857-	(4. international conference on ellipsometry, Berkeley, CA, USA, 20-23 Aug 1979)	
3	5:24971	*See* LBL-10172
CONF-790859-	(International conference on liquid scintillation counting--recent applications and development, San Francisco, CA, USA, 21-24 Aug 1979)	
3	5:24560	NTIS, PC A02/MF A01
CONF-790912-	(9. European conference on controlled fusion and plasma physics, Oxford, UK, 17-21 Sep 1979)	
13	5:23760	*See* UCRL-82530
CONF-790949-	(Energy resources workshop, Oak Ridge, TN, USA, 24-26 Sep 1979)	
3	5:23533	Dep. NTIS, PC A03/MF A01

Report No.	Abstract No.	Availability
CONF-790976-		(International symposium on future directions in studies of nuclei far from stability, Nashville, TN, USA, 10-13 Sep 1979)
9	5:24930	Dep. NTIS, PC A02/MF A01
10	5:24552	Dep. NTIS, PC A02/MF A01
CONF-790997-		(SAS-79 symposium on atomic spectroscopy, Tuscon, AZ, USA, 10-14 Sep 1979)
	5:24804	*See* DOE/ER/10460-1
CONF-7909134-		(Consultant symposium on rare gases in metals and ionic solids, Harwell, UK, 10-14 Sep 1979)
1	5:24423	*See* ORNL/TM-7193
CONF-791024-		(Solar industrial process heat conference, San Francisco, CA, USA, 31 Oct-2 Nov 1979)
	5:23856	*See* SERI/TP-333-429
	5:23861	*See* SERI/TP-333-429
	5:23905	*See* SERI/TP-333-429
	5:23906	*See* SERI/TP-333-429
	5:23907	*See* SERI/TP-333-429
	5:23908	*See* SERI/TP-333-429
	5:23909	*See* SERI/TP-333-429
	5:23910	*See* SERI/TP-333-429
	5:23911	*See* SERI/TP-333-429
	5:23912	*See* SERI/TP-333-429
	5:23913	*See* SERI/TP-333-429
	5:23914	*See* SERI/TP-333-429
	5:23915	*See* SERI/TP-333-429
	5:23916	*See* SERI/TP-333-429
	5:23917	*See* SERI/TP-333-429
	5:23918	*See* SERI/TP-333-429
	5:23919	*See* SERI/TP-333-429
	5:23920	*See* SERI/TP-333-429
	5:23921	*See* SERI/TP-333-429
	5:23922	*See* SERI/TP-333-429
	5:23923	*See* SERI/TP-333-429
	5:23924	*See* SERI/TP-333-429
	5:23925	*See* SERI/TP-333-429
	5:23926	*See* SERI/TP-333-429
	5:23927	*See* SERI/TP-333-429
	5:23928	*See* SERI/TP-333-429
	5:23929	*See* SERI/TP-333-429
	5:23930	*See* SERI/TP-333-429
	5:23931	*See* SERI/TP-333-429
	5:23932	*See* SERI/TP-333-429
	5:23933	*See* SERI/TP-333-429
	5:23934	*See* SERI/TP-333-429
	5:23935	*See* SERI/TP-333-429
	5:23936	*See* SERI/TP-333-429
	5:23937	*See* SERI/TP-333-429
	5:23938	*See* SERI/TP-333-429
	5:23939	*See* SERI/TP-333-429
	5:23940	*See* SERI/TP-333-429
	5:23955	*See* SERI/TP-333-429
	5:23956	*See* SERI/TP-333-429
	5:23957	*See* SERI/TP-333-429
	5:23958	*See* SERI/TP-333-429
CONF-791049-		(23. conference on analytical chemistry in energy technology, Gatlinburg, TN, USA, 9-11 Oct 1979)
26	5:24083	NTIS, PC A03/MF A01
CONF-791051-		(3. ASTM-EURATOM symposium on reactor dosimetry, Ispra, Italy, 1-5 Oct 1979)
23	5:24070	NTIS, PC A02/MF A01
CONF-791057-		(Workshop on hydrogen recycling, Livermore, CA, USA, 17-18 Oct 1979)
4	5:25010	NTIS, PC A02/MF A01
CONF-791058-		(International conference on nuclear cross sections for technology, Knoxville, TN, USA, 22-26 Oct 1979)
71	5:24084	NTIS, PC A02/MF A01
72	5:24992	NTIS, PC A02/MF A01
74	5:25084	NTIS, PC A02/MF A01
75	5:25085	NTIS, PC A02/MF A01
CONF-791059-		(4. international symposium on polynuclear aromatic hydrocarbons, Columbus, OH, USA, 2-4 Oct 1979)
6	5:24762	Dep. NTIS, PC A03/MF A01
8	5:24651	Dep. NTIS, PC A02/MF A01
CONF-791090-		(Symposium on potential environmental and health effects of atmospheric sulfur deposition, Gatlinburg, TN, USA, 14-18 Oct 1979)
7	5:24643	Dep. NTIS, PC A03/MF A01
CONF-7910108-		(Symposium on separation science and technology for energy applications, Gatlinburg, TN, USA, 30 Oct-2 Nov 1979)
4	5:23703	*See* PNL-SA-7844
CONF-7910116-		(Annual meeting of the American Physical Society, Montreal, Canada, 25-27 Oct 1979)
	5:24836	59: No. 1, 91-116(May 1980)
	5:24837	59: No. 1, 159-184(May 1980)
	5:24838	59: No. 1, 185-202(May 1980)
	5:24845	59: No. 1, 77-90(May 1980)
	5:24850	59: No. 1, 211-246(May 1980)
	5:24851	59: No. 1, 247-262(May 1980)
	5:24862	59: No. 1, 311-324(May 1980)
	5:24868	59: No. 1, 325-352(May 1980)
	5:24873	59: No. 1, 365-372(May 1980)
	5:24880	59: No. 1, 353-364(May 1980)
CONF-7910126-		(Biogas and alcohol production conference, Chicago, IL, USA, 25-26 Oct 1979)
2	5:23840	Chicago, IL; Institute of Gas Technology (1979).
CONF-7910133-		(Auto as a mode/industry sub-conference, Toronto, Canada, 4-5 Oct 1979)
	5:24285	Ottawa, Canada; Science Council of Canada (1980).
CONF-7910140-		(Bus/rail as modes and as industries sub-conference, Montreal, Canada, 25-26 Oct 1979)
	5:24272	Ottawa, Ontario; Science Council of Canada (1979).
CONF-7910141-		(2. symposium on environmental concerns in rights of way management, Ann Arbor, MI, USA, 16-18 Oct 1979)
1	5:24642	NTIS, PC A02/MF A01
CONF-7910146-		(International program for the evaluation of short-term tests for carcinogenicity, St Simons, GA, USA, 16-22 Oct 1979)
1	5:24763	Dep. NTIS, PC A02/MF A01
CONF-7910148-		(Giant multipole resonance topical conference, Oak Ridge, TN, USA, 15-17 Oct 1979)
1	5:24901	Dep. NTIS, PC A02/MF A01
CONF-7910149-		(6. international symposium on exoelectron emission and dosimetry, Arhenshoop, German Democratic Republic, 8-12 Oct 1979)
1	5:24561	NTIS, PC A02/MF A01
CONF-7910152-		(2. international total energy congress, Copenhagen, Denmark, 8-12 Oct 1979)
1	5:24101	NTIS, PC A03/MF A01
CONF-7910153-		(Electrical engineering meeting, Huntsville, AL, USA, 26 Oct 1979)
1	5:24194	Dep. NTIS, PC A02/MF A01
CONF-7910155-		(Ground water technology meeting, Oklahoma City, OK, USA, 10 Oct 1979)
1	5:23983	Dep. NTIS, PC A02/MF A01
CONF-7910156-		(US/USSR technical exchange and symposium in the areas of heat rejection systems, cogeneration and beneficial uses of waste heat, Washington, DC, USA, 15-17 Oct 1979)
2	5:24189	NTIS, PC A02/MF A01
CONF-7910159-		(International symposium on ill-posed problems: theory and practice, Newark, DE, USA, 2-6 Oct 1979)
1	5:25105	*See* BNL-27665
CONF-791102-		(8. symposium on engineering problems of fusion research, San Francisco, CA, USA, 13-16 Nov 1979)
161	5:25063	Dep. NTIS, PC A02/MF A01
163	5:25044	Dep. NTIS, PC A02/MF A01
164	5:25047	Dep. NTIS, PC A02/MF A01
165	5:25086	Dep. NTIS, PC A02/MF A01
166	5:25052	Dep. NTIS, PC A02/MF A01
167	5:25048	Dep. NTIS, PC A02/MF A01
168	5:25062	Dep. NTIS, PC A02/MF A01
169	5:24513	Dep. NTIS, PC A02/MF A01
171	5:25087	NTIS, PC A02/MF A01
CONF-791103-		(American Nuclear Society meeting, San Francisco, CA, USA, 12-16 Nov 1979)
107	5:24628	Dep. NTIS, PC A02/MF A01
110	5:24187	NTIS, PC A02/MF A01
111	5:24488	NTIS, PC A02/MF A01
CONF-791108-		(72. AICHE meeting, San Francisco, CA, USA, 25-29 Nov 1979)
24	5:24100	Dep. NTIS, PC A02/MF A01
CONF-791112-		(Symposium on the scientific basis for nuclear waste management, Boston, MA, USA, 26 Nov 1979,-29 Nov 1979/REPLACES CONF-791173)

Report No.	Abstract No.	Availability
62	5:24374	NTIS, PC A02/MF A01
63	5:23715	NTIS, PC A02/MF A01
65	5:24393	NTIS, PC A02/MF A01
CONF-791117-	(ANS topical conference, Kiawah Island, SC, USA, 26 Nov 1979,-19 Nov 1979/ REPLACES CONF-791180)	
26	5:24559	NTIS, PC A02/MF A01
27	5:23758	*See* BNL-27663
CONF-791118-	(7. water reactor safety research information meeting, Gaithersburg, MD, USA, 5-9 Nov 1979)	
10	5:24085	NTIS, PC A03/MF A01
11	5:24045	NTIS, PC A02/MF A01
CONF-791132-	(2. JIM international symposium on hydrogen in metals, Minakami Spa, Japan, 26-29 Nov 1979)	
5	5:24394	NTIS, PC A02/MF A01
CONF-791176-	(Japan-USA seminar on synchrotron radiation facilities, Honolulu, HI, USA, 5-9 Nov 1979)	
2	5:24556	*See* BNL-27654
CONF-791178-	(3. workshop on the Energy Development Board of Mercer County of North Dakota, Bismarck, ND, USA, 1-2 Nov 1979)	
	5:24177	Dep. NTIS, PC A03/MF A01
CONF-791183-	(Air as a mode/industry sub-conference, Edmonton, Canada, 29-30 Nov 1979)	
	5:24265	Ottawa, Ontario; Science Council of Canada (Feb 1980).
CONF-791185-	(ANS student chapter seminar, College Station, TX, USA, 5-9 Nov 1979)	
3	5:23671	NTIS, PC A03/MF A01
CONF-791186-	(Specialist meeting on neutronic calculational methods, Karlsruhe, F.R. Germany, 22-23 Nov 1979)	
1	5:24071	NTIS, PC A02/MF A01
CONF-791187-	(Symposium on pulse combustion technology for heating applications, Argonne, IL, USA, 29-30 Nov 1979)	
1	5:24248	*See* BNL-27602
CONF-791203-	(Health Physics Society meeting, Honolulu, HI, USA, 10-14 Dec 1979)	
9	5:23756	Dep. NTIS, PC A02/MF A01
CONF-791205-	(ASME winter annual meeting, New York, NY, USA, 2-7 Dec 1979)	
23	5:24053	NTIS, PC A02/MF A01
CONF-791241-	(42. session of the International Statistical Institute, Manila, Philippines, 4-14 Dec 1979)	
1	5:23572	NTIS, PC A02/MF A01
CONF-791242-	(4. annual thermal energy storage program review meeting, McLean, VA, USA, 2 Dec 1979,-4 Dec 1979/REPLACED BY CONF-791232)	
2	5:24249	NTIS, PC A02/MF A01
CONF-791243-	(Japanese Nuclear Data Committee nuclear data workshop, Tokai-mura Ibaraki-ken, Japan, 10-11 Dec 1979)	
1	5:24886	NTIS, PC A02/MF A01
CONF-800101-	(Systems simulation and economics analysis conference, San Diego, CA, USA, 23-25 Jan 1980)	
19	5:24304	Chicago, IL; Institute of Gas Technology, (1980).
CONF-800120-	(Conference on theoretical particle physics, Guangchou, China, 5-14 Jan 1980)	
3	5:24861	*See* BNL-27615
4	5:24875	*See* BNL-27617
CONF-800129-	(Energy from biomass and wastes 4 symposium, Lake Buena Vista, FL, USA, 21-25 Jan 1980)	
5	5:23841	Chicago, IL; Institute of Gas Technology (1979).
CONF-800138-	(Japan/US workshop on far-infrared diagnostics, Boston, MA, USA, 28-31 Jan 1980)	
1	5:24993	Dep. NTIS, PC A02/MF A01
CONF-800207-	(SPIE meeting, North Hollywood, CA, USA, 4-7 Feb 1980)	
3	5:23961	*See* SERI/TP-641-619
CONF-800213-	(Band structure and nuclear dynamics conference, New Orleans, LA, USA, 28 Feb-1 Mar 1980)	
11	5:24939	*See* LBL-10645
CONF-800234-	(10. thermochemical conversion contractors' meeting, Berkeley, CA, USA, 12-13 Feb 1980)	
1	5:23836	*See* LBL-10667
CONF-800235-	(ASM/SAMPE conference on specialized cleaning, finishing and coating processes, Los Angeles, CA, USA, 5-6 Feb 1980)	
1	5:24293	*See* LBL-10520
CONF-800309-	(International workshop on the energy/ climate interactions, Munster, F.R. Germany, 3-7 Mar 1980)	
5	5:24589	NTIS, PC A02/MF A01
CONF-800313-	(Waste management conference, Tucson, AZ, USA, 10 Mar 1980)	
7	5:23757	*See* RHO-SA-165
CONF-800320-	(3. topical conference on high temperature plasma diagnostics, Los Angeles, CA, USA, 17-19 Mar 1980)	
3	5:24995	*See* UCRL-83805
CONF-800324-	(Seminar on electrochemical systems: batteries and fuel cells, Fortaleza-Ceara, Brazil, 2-6 Mar 1980)	
2	5:24234	*See* BNL-27452
CONF-800334-	(2. DOE environmental control symposium, Reston, VA, USA, 17-19 Mar 1980)	
12	5:23862	*See* BNL-27710
CONF-800340-	(DOE active solar heating and cooling contractors' review meeting, Lake Tahoe, NV, USA, 26-28 Mar 1980)	
1	5:23952	*See* LA-UR-80-852
2	5:23884	*See* LA-UR-80-693
3	5:23953	*See* MLM-2702(OP)
6	5:23888	*See* LBL-10771
7	5:23887	*See* LBL-10770
CONF-800361-	(11. lunar and planetary science conference, Houston, TX, USA, Mar 1980)	
1	5:24801	*See* LA-UR-80-1199
CONF-800364-	(Conference on information sciences and systems, Princeton, NJ, USA, 26-28 Mar 1980)	
1	5:25104	*See* BNL-27513
CONF-800367-	(11. SE conference on combinatories, graph theory, and computing, Boca Raton, FL, USA, 3-7 Mar 1980)	
1	5:25112	*See* SAND-80-0438C
CONF-800401-	(2. international conference of liquid metal technology for energy systems, Richland, WA, USA, 20-24 Apr 1980)	
10	5:24055	*See* CRBRP-GEFR-SP-176
12	5:25090	*See* HEDL-SA-1889-FP
13	5:24056	*See* GEFR-SP-196
CONF-800403-	(ANS thermal reactor safety meeting, Knoxville, TN, USA, 8-11 Apr 1980)	
37	5:24097	*See* SAND-80-0888C
42	5:24094	*See* LA-UR-80-1069
43	5:24193	Dep. NTIS, PC A02/MF A01
CONF-800409-	(International conference on plasma physics, Nagoya, Japan, 7-11 Apr 1980)	
5	5:25006	*See* UCRL-84221
CONF-800414-	(DECUS spring symposium, Chicago, IL, USA, 22-25 Apr 1980)	
4	5:25073	*See* KMSF-U-970
CONF-800417-	(European Physicists Society and Swiss National Science Foundation conference, Zurich, Switzerland, 9-11 Apr 1980)	
2	5:24955	*See* LA-UR-80-1005
CONF-800427-	(Tritium technology in fission, fusion, and isotopic application, Dayton, OH, USA, 29 Apr-1 May 1980)	
6	5:25067	*See* LA-UR-80-1203
7	5:25068	*See* LA-UR-80-1249
8	5:25069	*See* LA-UR-80-1273
9	5:24489	*See* LA-UR-80-1215
10	5:23721	*See* LA-UR-80-1265
11	5:23765	*See* UCRL-83928
CONF-800433-	(4. international conference on nuclear methods in environment and energy research, Columbia, MO, USA, 14-17 Apr 1980)	
2	5:24487	*See* BNL-27611
3	5:23452	*See* BNL-27607
CONF-800434-	(CSNI specialist meeting on nuclear aerosols in reactor safety, Gatlinburg, TN, USA, 15-17 Apr 1980)	
2	5:24086	Dep. NTIS, PC A02/MF A01
CONF-800439-	(International conference on metallurgical coatings, San Diego, CA, USA, 21-25 Apr 1980)	
3	5:25092	*See* SAND-79-2105C

Report No.	Abstract No.	Availability
CONF-800441-	(International symposium on physics and open-ended fusion systems, Tsukuba, Japan, 15-18 Apr 1980)	
4	5:25013	*See* LA-UR-80-1109
5	5:25049	*See* LA-UR-80-1104
6	5:25045	*See* UCRL-84245
CONF-800446-	(2. international conference on emerging nuclear energy systems, Lausanne, Switzerland, 8-11 Apr 1980)	
2	5:25064	*See* UCRL-84018
CONF-800455-	(4. international conference on plasma surface interactions in controlled fusion devices, Garmisch, F.R. Germany, 21-25 Apr 1980)	
6	5:25093	*See* SAND-79-2409C
7	5:25004	*See* SAND-79-2338C
8	5:25088	Dep. NTIS, PC A02/MF A01
9	5:24594	*See* PPPL-1664
CONF-800456-	(Sherwood theory meeting, Tucson, AZ, USA, 23-25 Apr 1980)	
1(Rev.1)	5:25018	*See* UCRL-84044(Rev.1)
CONF-800460-	(82. annual American Ceramic Society meeting, Chicago, IL, USA, 27-30 Apr 1980)	
3	5:24395	*See* LA-UR-80-1252
CONF-800465-	(8. international geochemical exploration symposium, Hanover, F.R. Germany, 10-15 Apr 1980)	
2	5:23697	*See* LA-UR-80-1013
CONF-800471-	(Seminar on theory and applications of Monte Carlo methods, Oak Ridge, TN, USA, Apr 1980)	
1	5:24057	*See* LA-UR-80-1159
CONF-800474-	(Economic methodologies for climate change, Ft Lauderdale, FL, USA, 24-25 Apr 1980)	
1	5:24663	NTIS, PC A03/MF A01
CONF-800475-	(Southwestern Political Science Association annual meeting, Houston, TX, USA, 2-5 Apr 1980)	
1	5:24664	NTIS, PC A02/MF A01
CONF-800506-	(8. North American manufacturing research conference, Rolla, MO, USA, 18-21 May 1980)	
1	5:24508	*See* BDX-613-2375
CONF-800517-	(26. annual technical meeting of the Institute for Environmental Sciences, Philadelphia, PA, USA, 11-14 May 1980)	
4	5:23989	Dep. NTIS, PC A02/MF A01
5	5:24517	*See* UCRL-84327
CONF-800521-	(Symposium digest, Washington, DC, USA, 28-30 May 1980)	
1	5:24570	*See* SAND-80-0029C
CONF-800524-	(International congress on building energy management, Povoa de Varzim, Portugal, 12-16 May 1980)	
2	5:24250	NTIS, PC A02/MF A01
3	5:23886	*See* LBL-10034
CONF-800527-	(International BHP symposium, Columbus, OH, USA, 7-9 May 1980)	
2	5:23743	*See* SAND-80-0359C
3	5:23744	*See* SAND-80-0502C
4	5:24571	*See* SAND-80-0408C
CONF-800530-	(International conference on materials for photothermal energy conversion, Corsica, France, 6-8 May 1980)	
1	5:23954	*See* SAND-79-2371C
CONF-800532-	(Core components working group information meeting, Richland, WA, USA, 13-15 May 1980)	
1	5:24058	*See* LA-UR-80-1283
CONF-800534-	(Seminar series on traceability for ionizing radiation measurements, Gaithersburg, MD, USA, 8-9 May 1980)	
1	5:24573	*See* UCRL-84295
CONF-800535-	(ASME Idaho section symposium, Idaho Falls, ID, USA, 29 May 1980)	
1	5:23717	*See* DP-MS-80-39
CONF-800536-	(American Engineering Model Society seminar '80, Pittsburgh, PA, USA, 5-8 May 1980)	
1	5:24087	NTIS, PC A02/MF A01
CONF-800537-	(Symposium on finite elements, Storrs, CT, USA, 2 May 1980)	
1	5:25110	*See* KAPL-4134
CONF-800538-	(ACS meeting-in-miniature, Tampa, FL, USA, 8-10 May 1980)	
1	5:24495	*See* GEPP-OP-482
3	5:24505	*See* GEPP-OP-501
4	5:24494	*See* GEPP-OP-474a
CONF-800541-	(Tar sands permeability enhancement workshop, Albuquerque, NM, USA, 8-9 May 1980)	
1	5:23620	*See* SAND-80-1134
CONF-800543-	(5. national workshop on entrainment and impingement, San Francisco, CA, USA, 5-7 May 1980)	
2	5:24024	NTIS, PC A02/MF A01
3	5:24025	NTIS, PC A02/MF A01
4	5:24026	NTIS, PC A02/MF A01
CONF-800545-	(International powder and bulk solids conference and exhibition, Rosemont, IL, USA, 13-15 May 1980)	
1	5:23559	Dep. NTIS, PC A02/MF A01
CONF-800548-	(Eastern Economic Association annual meeting, Montreal, Quebec, Canada, 8-10 May 1980)	
1	5:24305	NTIS, PC A02/MF A01
2	5:24201	*See* BNL-27721
CONF-800549-	(11. annual modeling and simulation conference, Pittsburgh, PA, USA, 1 May 1980)	
1	5:24306	NTIS, PC A02/MF A01
CONF-800550-	(Anomalous absorption meeting, San Francisco, CA, USA, 28-30 May 1980)	
1	5:24983	*See* UCRL-84270
CONF-800551-	(Symposium on neutron cross sections from 10 - 50 MeV, Upton, NY, USA, 12-14 May 1980)	
1	5:24927	*See* UCRL-84370
CONF-800604-	(American section of the International Solar Energy Society conference, Phoenix, AZ, USA, 2-6 Jun 1980)	
14	5:23820	*See* SAND-80-0926C
15	5:23885	*See* LA-UR-80-1014
16	5:23844	*See* SERI/TP-623-656
17	5:23860	*See* SERI/TP-641-653
19	5:24003	*See* SERI/TP-731-649
21	5:23877	*See* BNL-27711
CONF-800607-	(American Nuclear Society annual meeting, Las Vegas, NV, USA, 8-13 Jun 1980)	
15	5:24088	Dep. NTIS, PC A02/MF A01
24	5:24073	*See* BNL-NUREG-27192
31	5:23740	*See* RHO-SA-155
33	5:24054	NTIS, PC A02/MF A01
34	5:24936	*See* DP-MS-79-106
CONF-800611-	(International symposium on the management of alpha-contaminated wastes, Vienna, Austria, 2-6 Jun 1980)	
5	5:23720	*See* LA-UR-80-1168
CONF-800617-	(7. international conference on MHD electrical power generation, Cambridge, MA, USA, 16-20 Jun 1980)	
1	5:24222	*See* DOE/NASA/2674-80/10
2	5:24218	*See* DOE/NASA/2674-80/9
CONF-800620-	(16. AIAA-SAE-ASME joint propulsion conference, Hartford, CT, USA, 30 Jun-2 Jul 1980)	
2	5:24584	*See* UCRL-83727
CONF-800624-	(Power electronics specialists conference, Atlanta, GA, USA, 17-19 Jun 1980)	
2	5:23852	*See* SAND-80-0873C
CONF-800627-	(Halden project conference, Halden, Norway, 1-6 Jun 1980)	
1	5:24078	NTIS, PC A02/MF A01
CONF-800629-	(Symposium on commercial uses of geothermal energy, Boise, ID, USA, 16-18 Jun 1980)	
1	5:23999	*See* LBL-10848
CONF-800704-	(NATO/CCMS meeting on pilot studies, Paris, France, 15 Jul 1980)	
1	5:23979	*See* LBL-10615
CONF-800705-	(12. international glass congress, Albuquerque, NM, USA, 6-11 Jul 1980)	
1	5:23960	*See* SERI/TP-334-565
CONF-800707-	(8. international conference on plasma physics and controlled nuclear fusion research, Brussels, Belgium, 1-10 Jul 1980)	
1	5:25066	*See* LA-UR-79-2971
CONF-800708-	(8. international conference on cloud physics, Clermont-Ferrand, France, 15-19 Jul 1980)	
1	5:24635	*See* UCRL-83583
CONF-800710-	(Drying '80 conference, Montreal, Quebec, Canada, 7-9 Jul 1980)	

Report No.	Abstract No.	Availability
1	5:23541	*See* LA-UR-80-551
CONF-800711-	(21. annual logging symposium, Lafayette, LA, USA, 8-11 Jul 1980)	
1	5:23988	*See* LA-UR-80-670
CONF-800712-	(15. AIAA thermophysics conference, Snowmass, CO, USA, 14-16 Jul 1980)	
1	5:24368	*See* K/CSD/INF-79/27
CONF-800713-	(7. international pyrotechnics seminar, Vail, CO, USA, 14-18 Jul 1980)	
1	5:24583	*See* SAND-80-0355C
2	5:24413	*See* MLM-2707(OP)
5	5:24430	*See* SAND-80-0427C
6	5:24580	*See* MLM-2708(OP)
7	5:24581	*See* MLM-2709(OP)
8	5:24582	*See* MLM-2710(OP)
9	5:24437	*See* MLM-2711(OP)
CONS-		
3288-T6	5:24335	NTIS, PC A07/MF A01
4209-T1(Vol.5)	5:24349	NTIS, PC A05/MF A01
4209-T1(Vol.10)	5:24342	Dep. NTIS, PC A05/MF A01
5085-T2	5:24099	NTIS, PC A06/MF A01
8138-T1	5:24210	NTIS, PC A05/MF A01
COO-		
2218-160	5:25011	NTIS, PC A05/MF A01
2571-19	5:24089	NTIS, PC A02/MF A01
2608-3	5:23950	Dep. NTIS, PC A04/MF A01
2975-40	5:24049	NTIS, PC A04/MF A01
3004-2	5:23804	NTIS, PC A03/MF A01
3075-224	5:24876	NTIS, PC A03/MF A01
3244-72	5:24896	NTIS, PC A06/MF A01
3382-18	5:24752	NTIS, PC A06/MF A01
3382-18	5:24753	NTIS, PC A06/MF A01
3382-18	5:24755	NTIS, PC A06/MF A01
3382-18	5:24756	NTIS, PC A06/MF A01
3382-18	5:24757	NTIS, PC A06/MF A01
3382-18	5:24758	NTIS, PC A06/MF A01
3382-18	5:24759	NTIS, PC A06/MF A01
3382-18	5:24760	NTIS, PC A06/MF A01
4049-16	5:24217	NTIS, PC A02/MF A01
4094-64	5:23805	NTIS, PC A03/MF A01
4159-5	5:24709	Dep. NTIS, PC A02/MF A01
4261-14	5:24090	Dep. NTIS, PC A03/MF A01
4325-02	5:24046	Dep. NTIS, PC A07/MF A01
4433-3	5:24022	Dep. NTIS, PC A02/MF A01
4596-1(Vol.3)	5:25107	Dep. NTIS, PC A07/MF A01
4881-3	5:24498	Dep. NTIS, PC A04/MF A01
4929-5	5:24291	NTIS, PC A03/MF A01
4930-1	5:24297	NTIS, PC A09/MF A01
4965-1	5:24590	Dep. NTIS, PC A03/MF A01
4975-1(Vol.2)(App.)	5:24325	NTIS, PC A08/MF A01
4975-(Vol.1)(Text)	5:24322	NTIS, PC A16/MF A01
4980-1	5:24323	NTIS, PC A14/MF A01
4980-1(Exec.Summ.)	5:24324	NTIS, PC A02/MF A01
CRBRP-GEFR-SP-176	5:24055	NTIS, PC A02/MF A01
CSA-PAMPHLET-6143-15	5:24251	Community Services Administration, Office of Energy Programs, Washington, DC
CW-WR-		
76-015.34A	5:23561	*See* FE-1726-34A
78-036-11A	5:23459	*See* FE-3269-11A
DGE-		
4008-F	5:23996	Dep. NTIS, PC A03/MF A01
DOE/BC/10069-6	5:23575	Dep. NTIS, PC A06/MF A01
DOE/BC/20006-14	5:23573	Dep. NTIS, PC A04/MF A01
DOE/BETC-		
80/1	5:23576	NTIS, PC A07/MF A01
DOE/BETC/5785-1	5:23577	Dep. NTIS, PC A22/MF A01
DOE/BETC/RI-		
80/3	5:23578	Dep. NTIS, PC A02/MF A01
DOE/CS-		
0162	5:24190	Dep. NTIS, PC A05/MF A01
T0145	5:23879	Dep. NTIS, PC A06/MF A01
DOE/CS/1697-01	5:24191	NTIS, PC A11/MF A01
DOE/CS/4042-T36	5:23775	NTIS, PC A02/MF A01
DOE/CS/02130-T1	5:24252	Dep. NTIS, PC A02/MF A01
DOE/CS/34154-1	5:23880	NTIS, PC A04/MF A01
2-3	5:23881	NTIS, PC A02/MF A01
DOE/CS/34163-2	5:23951	NTIS, PC A03/MF A01
DOE/CS/40021-1	5:24298	NTIS, PC A12/MF A01
DOE/CS/40056-T1	5:24299	NTIS, PC A02/MF A01
DOE/CS/40167-T1	5:24307	NTIS, PC A05/MF A01
DOE/CS/40221-6	5:24292	NTIS, PC A02/MF A01
DOE/CS/40255-1	5:24308	NTIS, PC A10/MF A01
DOE/DP/01253-18	5:24780	NTIS, PC A03/MF A01
DOE/DP/40001-1	5:24521	Dep. NTIS, PC A03/MF A01
DOE/DP/40100-1	5:24522	NTIS, PC A03/MF A01
DOE/EA-		
0095	5:23659	NTIS, PC A05/MF A01
DOE/EIA-		
0201/5	5:24195	NTIS, PC A04/MF A01
0201/6	5:24202	NTIS, PC A05/MF A01
0207/2	5:24253	Dep. NTIS, PC A06/MF A01
0207/3	5:24254	NTIS, PC A09/MF A01
DOE/EIA/10480-T1	5:24006	Dep. NTIS, PC A05/MF A01
DOE/EIS-		
0015(Vol.1)	5:23723	NTIS, PC E03/MF E03
0015(Vol.2)	5:23724	NTIS, PC E05/MF E05
0015(Vol.3)	5:23725	NTIS, PC E03/MF E03
0015(Vol.4)	5:23726	NTIS, PC E03/MF E03
0015(Vol.5)	5:23727	NTIS, PC E05/MF E05
DOE/ER-		
0049/1	5:23865	Dep. NTIS, PC A03/MF A01
0050	5:23798	Dep. NTIS, PC A04/MF A01
0052	5:23846	NTIS, PC A02/MF A01
0053	5:23847	Dep. NTIS, PC A07/MF A01
0054	5:23848	Dep. NTIS, PC A03/MF A01
0055	5:23849	NTIS, PC A05/MF A01
0056	5:23850	Dep. NTIS, PC A06/MF A01
DOE/ER/01198-1305	5:24499	Dep. NTIS, PC A07/MF A01
DOE/ER/01545-274	5:24867	NTIS, PC A02/MF A01
DOE/ER/03069-770	5:24835	NTIS, PC A02/MF A01
DOE/ER/06036-3	5:24805	Dep. NTIS, PC A04/MF A01
DOE/ER/10430-1	5:24386	NTIS, PC A02/MF A01
DOE/ER/10460-1	5:24804	Dep. NTIS, PC A13/MF A01
DOE/ER/10471-1	5:24509	NTIS, PC A04/MF A01
DOE/ER/10494-1	5:24887	NTIS, PC A02/MF A01
DOE/ER/10512-T1	5:24819	NTIS, PC A03/MF A01
DOE/ER/10516-T2	5:24844	NTIS, PC A03/MF A01
T3	5:24871	NTIS, PC A02/MF A01
DOE/ET-		
0065/8	5:25089	Dep. NTIS, PC A08/MF A01
DOE/ET/10254-T2	5:23418	NTIS, PC A02/MF A01
DOE/ET/12438-T1	5:24510	NTIS, PC A06/MF A01
DOE/ET/13152-1	5:23560	NTIS, PC A03/MF A01
DOE/ET/14803-T4	5:23438	Dep. NTIS, PC A03/MF A01
DOE/ET/15209-T1	5:24010	Dep. NTIS, PC A06/MF A01
DOE/ET/15350-T1	5:24309	NTIS, PC A06/MF A01
DOE/ET/15457-4	5:24015	NTIS, PC A02/MF A01
10	5:24011	NTIS, PC A02/MF A01
DOE/ET/20611-12	5:23835	NTIS, PC A02/MF A01
DOE/ET/21002-1	5:23866	Dep. NTIS, PC A06/MF A01

Report No.	Abstract No.	Availability
DOE/ET/23010-12	5:23806	NTIS, PC A03/MF A01
DOE/ET/23033-16	5:24457	NTIS, PC A03/MF A01
DOE/ET/23040-4	5:23807	NTIS, PC A04/MF A01
DOE/ET/23045-1	5:23808	NTIS, PC A03/MF A01
DOE/ET/27025-T1	5:23998	NTIS, PC A03/MF A01
DOE/ET/29187-T3	5:23867	Dep. NTIS, PC A07/MF A01
DOE/ET/37205-T1	5:24091	NTIS, PC A07/MF A01
DOE/ET/47936-4	5:23706	NTIS, PC A03/MF A01
DOE/EV-0068	5:23993	Dep. NTIS, PC A07/MF A01
0078	5:23660	NTIS, PC A06/MF A01
DOE/EV/2856-5	5:23453	Dep. NTIS, PC A03/MF A01
DOE/EV/02472-6	5:24667	NTIS, PC A02/MF A01
DOE/EV/02874-64	5:25108	NTIS, PC A02/MF A01
68	5:24751	NTIS, PC A03/MF A01
69	5:24776	NTIS, PC A03/MF A01
DOE/EV/03221-61	5:24733	NTIS, PC A02/MF A01
62	5:24734	NTIS, PC A02/MF A01
63	5:24735	NTIS, PC A02/MF A01
64	5:24744	NTIS, PC A02/MF A01
65	5:24670	NTIS, PC A02/MF A01
66	5:24504	NTIS, PC A02/MF A01
DOE/EV/04651-T1	5:24214	Dep. NTIS, PC A03/MF A01
DOE/EV/10281-1	5:24591	Dep. NTIS, PC A02/MF A01
DOE/ID/01570-T4	5:24565	NTIS, PC A03/MF A01
DOE/ID/12019-1	5:23990	NTIS, PC A02/MF A01
DOE/IR/0033-T2	5:24332	NTIS, PC A03/MF A01
DOE/JPL-1060-31	5:23859	NTIS, PC A03/MF A01
DOE/JPL/954331-80/9	5:23809	Dep. NTIS, PC A13/MF A01
80/9(Vol.2)	5:23810	Dep. NTIS, PC A10/MF A01
DOE/JPL/954853-80/9	5:23811	NTIS, PC A02/MF A01
DOE/JPL/955077-79	5:23812	NTIS, PC A06/MF A01
DOE/JPL/955089-80/6	5:23813	Dep. NTIS, PC A05/MF A01
DOE/JPL/955342-4	5:23814	NTIS, PC A02/MF A01
DOE/JPL/955533-79/1	5:23815	Dep. NTIS, PC A04/MF A01
DOE/LETC/10787-44	5:23625	NTIS, PC A03/MF A01
DOE/MC/03259-6	5:23579	NTIS, PC A04/MF A01
DOE/NASA/0026-79/1	5:24004	Dep. NTIS, PC A03/MF A01
DOE/NASA/0058-79/2(Vol.1)	5:24005	NTIS, PC A15/MF A01
DOE/NASA/1040-80/14	5:24337	Dep. NTIS, PC A03/MF A01
DOE/NASA/2674-80/9	5:24218	NTIS, PC A02/MF A01
80/10	5:24222	Dep. NTIS, PC A02/MF A01
DOE/NASA/9416-80/2	5:24338	NTIS, PC A05/MF A01
DOE/NASA/CR-161414	5:23904	Dep. NTIS, PC A07/MF A01
DOE/NE-0005	5:23728	NTIS, PC A04/MF A01
DOE/NOAA/OTEC-29(Summ.)	5:23868	NTIS, PC A06/MF A01
DOE/OR/00033-T1	5:24333	NTIS, PC A08/MF A01
DOE/PC/20023-1	5:23458	Dep. NTIS, PC A02/MF A01
DOE/PE-00/8	5:24196	Dep. NTIS, PC A04/MF A01
0019(Vol.1)	5:23600	Dep. NTIS, PC A10/MF A01
DOE/PE/70106-T1	5:24255	NTIS, PC A03/MF A01
DOE/PR-0038	5:24173	NTIS, PC A03/MF A01
DOE/RA/10001-T1	5:24027	Dep. NTIS, PC A04/MF A01
DOE/RA/50076-T1	5:23980	NTIS, PC A02/MF A01
DOE/RG-0028	5:24203	Dep. NTIS, PC A04/MF A01
DOE/S-0005(79)	5:24174	NTIS, PC A07/MF A01
DOE/SERI-8119-3/1	5:23816	NTIS, PC A03/MF A01
DOE/SR-0004(Vol.1)	5:23707	NTIS, PC A03/MF A01
0004(Vol.2)	5:23708	NTIS, PC A05/MF A01
DOE/TIC-11177	5:24211	Dep. NTIS, PC A05/MF A01
11192	5:24511	NTIS, PC A02/MF A01
11202	5:24420	NTIS, PC A03/MF A01
11203	5:24592	NTIS, PC A03/MF A01
DP-1540	5:23716	NTIS, PC A03/MF A01
DP-MS-79-106	5:24936	NTIS, PC A02/MF A01
80-39	5:23717	NTIS, PC A03/MF A01
DP-TR-9	5:24493	NTIS, PC A02/MF A01
DPSPU-80-30-1	5:24629	NTIS, PC A04/MF A01
DPST-79-146-13	5:23694	*See* GJBX-107(80)
79-146-15	5:23695	*See* GJBX-108(80)
80-146-5	5:23683	*See* GJBX-91(80)
80-146-15	5:23682	*See* GJBX-81(80)
DSE-0034-T1	5:23869	Dep. NTIS, PC A08/MF A01
4042-T17	5:23817	Dep. NTIS, PC A03/MF A01
4042-T30	5:23818	NTIS, PC A03/MF A01
EGG-2015	5:25109	NTIS, PC A05/MF A01
2027	5:24290	NTIS, PC A03/MF A01
EGG-FM-5078	5:24092	Dep. NTIS, PC A02/MF A01
EGG/LTR-LO-0080-113	5:24081	Dep. NTIS, PC A12/MF A01
EMSL-LV-0539-33	5:24641	Dep. NTIS, PC A08/MF A01
0539-36	5:24630	NTIS, PC A06/MF A01
ENICO-1026	5:23718	NTIS, PC A02/MF A01
1036	5:23719	Dep. NTIS, PC A03/MF A01
EPA-600/7-79-238	5:24031	NTIS
600/9-79-015	5:24593	NTIS
600/9-79-016	5:24594	NTIS
EPRI-AF-1242	5:23419	Dep. NTIS, PC A03/MF A01
1255	5:23439	Dep. NTIS, PC A11/MF A01
1294	5:24197	Dep. NTIS, PC A06/MF A01
EPRI-EL-1263	5:24074	Dep. NTIS, PC A10/MF A01
1263	5:24075	Dep. NTIS, PC A10/MF A01
1263	5:24440	Dep. NTIS, PC A10/MF A01
1263	5:24441	Dep. NTIS, PC A10/MF A01
1263	5:24442	Dep. NTIS, PC A10/MF A01
1263	5:24446	Dep. NTIS, PC A10/MF A01
1263	5:24447	Dep. NTIS, PC A10/MF A01
1263	5:24448	Dep. NTIS, PC A10/MF A01
1263	5:24449	Dep. NTIS, PC A10/MF A01
1263	5:24450	Dep. NTIS, PC A10/MF A01
1263	5:24451	Dep. NTIS, PC A10/MF A01
1263	5:24452	Dep. NTIS, PC A10/MF A01
1263	5:24531	Dep. NTIS, PC A10/MF A01
EPRI-ER-1239(Vol.4)	5:23882	Dep. NTIS, PC A10/MF A01
EPRI-FP-1251	5:24007	Dep. NTIS, PC A04/MF A01
1307(Vol.1)	5:24032	Dep. NTIS, PC A05/MF A01
1307(Vol.2)	5:24033	Dep. NTIS, PC A06/MF A01
EPRI-NP-1186	5:24016	Dep. NTIS, PC A04/MF A01
1313	5:24043	Dep. NTIS, PC A04/MF A01
EUR-6701	5:23883	NTIS, PC Q04/MF A01

Report No.	Abstract No.	Availability
FE-		
0208-T1	5:23420	NTIS, PC A05/MF A01
1514-97	5:23421	NTIS, PC A07/MF A01
1517-89	5:23440	NTIS, PC A03/MF A01
1517-90	5:23441	NTIS, PC A03/MF A01
1517-91	5:23442	NTIS, PC A04/MF A01
1517-92	5:23443	NTIS, PC A03/MF A01
1726-34A	5:23561	Dep. NTIS, PC A06/MF A01
1765-44	5:24017	NTIS, PC A13/MF A01
1806-86	5:24018	NTIS, PC A05/MF A01
2006-17	5:23444	NTIS, PC A02/MF A01
2012-083	5:23422	NTIS, PC A04/MF A01
2030-TR18	5:23454	NTIS, PC A04/MF A01
2030-TR20	5:23455	NTIS, PC A07/MF A01
2030-TR21	5:23456	NTIS, PC A05/MF A01
2044-51	5:23445	NTIS, PC A02/MF A01
2215-13(Vol.1)	5:24215	Dep. NTIS, PC A17/MF A01
2215-13(Vol.1)	5:24223	Dep. NTIS, PC A17/MF A01
2215-13(Vol.1)	5:24224	Dep. NTIS, PC A17/MF A01
2215-13(Vol.1)	5:24225	Dep. NTIS, PC A17/MF A01
2215-13(Vol.1)	5:24226	Dep. NTIS, PC A17/MF A01
2215-13(Vol.2)	5:24216	Dep. NTIS, PC A21/MF A01
2215-13(Vol.2)	5:24219	Dep. NTIS, PC A21/MF A01
2215-13(Vol.2)	5:24220	Dep. NTIS, PC A21/MF A01
2215-13(Vol.2)	5:24227	Dep. NTIS, PC A21/MF A01
2215-13(Vol.2)	5:24228	Dep. NTIS, PC A21 MF/A01
2215-13(Vol.2)	5:24229	Dep. NTIS, PC A21/MF A01
2248-23	5:24221	Dep. NTIS, PC A16/MF A01
2304-43	5:23562	NTIS, PC A04/MF A01
2315-45	5:23446	NTIS, PC A05/MF A01
2338-14	5:23423	NTIS, PC A07/MF A01
2346-37	5:23643	NTIS, PC A02/MF A01
2346-48	5:23626	NTIS, PC A02/MF A01
2346-58	5:23627	NTIS, PC A03/MF A01
2346-64	5:23628	NTIS, PC A03/MF A01
2469-48	5:23424	NTIS, PC A04/MF A01
2566-33	5:23447	NTIS, PC A06/MF A01
2612-16	5:24012	Dep. NTIS, PC A04/MF A01
2696-T4	5:23448	NTIS, PC A02/MF A01
2709-T1	5:23412	NTIS, PC A03/MF A01
2729-8	5:23425	NTIS, PC A03/MF A01
2762-7	5:23426	Dep. NTIS, PC A04/MF A01
2786-38	5:24019	NTIS, PC A21/MF A01
3125-15	5:23427	NTIS, PC A05/MF A01
3134-1	5:23536	NTIS, PC A02/MF A01
3134-2	5:23537	NTIS, PC A17/MF A01
3137-T1	5:23449	Dep. NTIS, PC A12/MF A01
3162-T1	5:24023	Dep. NTIS, PC A06/MF A01
3242-11	5:24034	NTIS, PC A02/MF A01
3269-11A	5:23459	NTIS, PC A09/MF A01
9145-1	5:23540	NTIS, PC A13/MF A01
GE/ARSD-		
00027	5:24082	*See* ALO-66
GEFR-SP-		
196	5:24056	NTIS, PC A02/MF A01
GEPP-FR-		
434	5:24537	NTIS, PC A04/MF A01
GEPP-OP-		
474a	5:24494	NTIS, PC A03/MF A01
482	5:24495	NTIS, PC A03/MF A01
501	5:24505	NTIS, PC A02/MF A01
GJBX-		
51(80)	5:23675	NTIS, PC A03/MF A01
54(80)	5:23676	NTIS, PC A03/MF A01
73(80)(Vol.1)	5:23677	NTIS, PC, $8.50/MF, $3.50
73(80)(Vol.2)	5:23678	NTIS, PC A06/MF A01
79(80)(Vol.1)	5:23679	NTIS, PC, $10.50/MF, $3.65
79(80)(Vol.2)	5:23680	NTIS, PC A06/MF A01
80-(80)(Vol.1)	5:23681	NTIS, PC, $10.50/MF, $3.65
81(80)	5:23682	NTIS, PC, $8.50/MF, $3.50
91(80)	5:23683	NTIS, PC, $12.50/MF, $5.15
92(80)	5:23684	NTIS, PC A04/MF A01
95(80)	5:23685	NTIS, PC, $33.50/MF, $17.30
96(80)(Vol.1)	5:23686	NTIS, PC A04/MF A01
96(80)(Vol.2)	5:23687	NTIS, PC, $8.50/MF, $3.50
97(80)	5:23688	NTIS, PC, $8.15/MF, $3.50
99(80)	5:23689	NTIS, PC, $27.50/MF, $3.50
100(80)	5:23690	NTIS, PC, $33.50/MF, $3.50
101(80)	5:23691	NTIS, PC, $22.50/MF, $9.80
104(80)	5:23692	NTIS, PC, $33.50/MF, $19.25
106(80)	5:23693	NTIS, PC, $24.50/MF, $3.50
107(80)	5:23694	NTIS, PC, $33.50/MF, $3.95
108(80)	5:23695	NTIS, PC, $30.50/MF, $5.45
112(80)	5:23673	NTIS, PC A06/MF A01
HEDL-SA-		
1774-FP	5:24421	NTIS, PC A02/MF A01
1889-FP	5:25090	Dep. NTIS, PC A02/MF A01
HEDL-TME-		
75-85	5:24093	NTIS, PC A13/MF A01
HNEI-		
7902	5:24039	Hawaii Natural Energy Institute, Manoa
IEA/EAS-		
B2/79(Draft)	5:23515	IEA Coal Research, Economic Assessment Service, London, England
IEAL-		
120	5:24072	*See* ALO-63
IKE-K-		
54-19	5:24176	Dep. NTIS (US Sales Only), PC A02/MF A01
JPRS-		
74056	5:24732	NTIS, PC A99/MF A01
Juel-Spez-		
55	5:24204	Dep. NTIS (US Sales Only), PC A04/MF A01
K/CSD/INF-		
79/27	5:24368	NTIS, PC A02/MF A01
K/P-		
6567	5:24518	NTIS, PC A02/MF A01
K/UR-		
33	5:23690	*See* GJBX-100(80)
135	5:23689	*See* GJBX-99(80)
136	5:23693	*See* GJBX-106(80)
KAPL-		
4134	5:25110	Dep. NTIS, PC A02/MF A01
KMSF-U-		
970	5:25073	NTIS, PC A02/MF A01
LA-		
8041-MS(Rev)	5:24047	Dep. NTIS, PC A11/MF A01
8087	5:24890	NTIS, PC A02/MF A01
8104-PR	5:23619	NTIS, PC A05/MF A01
8145	5:24486	NTIS, PC A02/MF A01
8177	5:23729	NTIS, PC A02/MF A01
8221	5:24647	Dep. NTIS, PC A03/MF A01
8226-MS	5:24978	NTIS, PC A02/MF A01
8252-MS	5:23987	NTIS, PC A03/MF A01
8276-MAP	5:23984	NTIS, PC A03/MF A01
8293-PR	5:24553	Dep. NTIS, PC A04/MF A01
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301117	5:24276	NTIS, PC A06/MF A01
301135	5:24206	NTIS, PC A10/MF A01
301143	5:24256	NTIS, PC A02/MF A01
301144	5:24783	NTIS, PC A22/MF A01
301147	5:24266	NTIS, PC A04/MF A01
301152-SET/SL	5:24277	NTIS PCE12
301153	5:24278	NTIS, PC A04/MF A01
301154	5:24279	NTIS, PC A11/MF A01
301155	5:24280	NTIS, PC A07/MF A01
301156	5:24281	NTIS, PC A07/MF A01
301162	5:24353	NTIS, PC A07/MF A01
301172	5:24282	NTIS, PC A03/MF A01
301200	5:24257	NTIS, PC A99/MF A01
301215	5:24354	NTIS, PC A03/MF A01
301221	5:24665	NTIS, PC A05/MF A01
301224	5:24355	NTIS, PC A02/MF A01
301234	5:24640	NTIS, PC A03/MF A01
301242	5:24618	NTIS, PC A04/MF A01
301244	5:24302	NTIS, PC A05/MF A01
301249	5:23529	NTIS, PC A10/MF A01
301253	5:23530	NTIS, PC A07/MF A01
301256	5:23773	NTIS, PC A03/MF A01
301288	5:24619	NTIS, PC A04/MF A01
301294	5:24620	NTIS, PC A20/MF A01
301308	5:24009	NTIS, PC A11/MF A01
301313	5:24666	NTIS, PC A99/MF A01
301319	5:24283	NTIS, PC A09/MF A01
301365	5:23566	NTIS, PC A12/MF A01
301366	5:24621	NTIS, PC A14/MF A01
301367	5:24040	NTIS, PC A08/MF A01
301368	5:24622	NTIS, PC A04/MF A01
301384	5:24623	NTIS, PC A05/MF A01
301409	5:24428	NTIS, PC A17/MF A01
301410	5:24356	NTIS, PC A02/MF A01
PNL-		
2410(Rev.2)	5:24182	NTIS, PC A02/MF A01
2859	5:23735	NTIS, PC A03/MF A01
2862	5:23736	NTIS, PC A06/MF A01
2874	5:23737	NTIS, PC A15/MF A01
3081	5:24668	Dep. NTIS, PC A02/MF A01
3166(Pt.1)	5:23702	NTIS, PC A04/MF A01
3171	5:23709	Dep. NTIS, PC A05/MF A01
3209	5:24754	NTIS, PC A10/MF A01
3318	5:23738	Dep. NTIS, PC A06/MF A01
PNL-SA-		
7820	5:23891	Dep. NTIS, PC A06/MF A01
7844	5:23703	NTIS, PC A02/MF A01
PNL-TR-		
393	5:24061	NTIS, PC A02/MF A01
397	5:24079	NTIS, PC A02/MF A01
398	5:24060	NTIS, PC A02/MF A01
PPI-		
1030-6	5:24004	*See* DOE/NASA/0026-79/1
PPPL-		
1658	5:24980	NTIS, PC A03/MF A01
1659	5:25017	NTIS, PC A02/MF A01
1662	5:25003	NTIS, PC A02/MF A01
1663	5:25026	NTIS, PC A03/MF A01
1664	5:24994	NTIS, PC A03/MF A01
1666	5:25091	NTIS, PC A03/MF A01
RDT-F-		
3-6T-(4-80)(Amendt)	5:24567	NTIS, PC A02/MF A01
3-6T(ERRATA)	5:24566	RSO
RDT-M-		
3-4T(4-80)(Rev.)	5:24068	RSO
3-34T(4-80)(Rev.)	5:24067	RSO
RFP-		
3090	5:24490	NTIS, PC A02/MF A01
RFP-ENV-		
79	5:24646	Dep. NTIS, PC A03/MF A01
RHO-BWI-C-		
59	5:23739	NTIS, PC A23/MF A01
RHO-CD-		
883	5:23714	NTIS, PC A04/MF A01
RHO-SA-		
155	5:23740	Dep. NTIS, PC A02/MF A01
165	5:23757	NTIS, PC A02/MF A01
RLO-		
2325	5:23997	Dep. NTIS, PC A04/MF A01
RRC-		
79-R-627	5:23892	*See* SAND-78-8176
SAI-		
129-79-PGH	5:24543	Dep. NTIS, PC A10/MF A01
SAN-		
0115-T7	5:24096	Dep. NTIS, PC A06/MF A01
1176-T1(Vol.1)	5:24267	NTIS, PC A03/MF A01
1176-T1(Vol.2)	5:24268	NTIS, PC A07/MF A01
1176-T1(Vol.3)	5:24269	NTIS, PC A06/MF A01
1176-T1(Vol.4)	5:24270	NTIS, PC A08/MF A01
1176-T3	5:24271	NTIS, PC A05/MF A01
1212-T1	5:24357	Dep. NTIS, PC A20/MF A01
1429-52	5:23429	NTIS, PC A04/MF A01
1701-T1	5:24319	Dep. NTIS, PC A12/MF A01
1731-T3	5:24303	NTIS, PC A07/MF A01
2192-T1	5:23851	NTIS, PC A07/MF A01
SAND-		
78-1331	5:23754	NTIS, PC A06/MF A01
78-8176	5:23892	Dep. NTIS, PC A07/MF A01
79-0278	5:23741	NTIS, PC A04/MF A01
79-1278	5:23742	NTIS, PC A03/MF A01
79-1424	5:24519	NTIS, PC A03/MF A01
79-2105C	5:25092	NTIS, PC A02/MF A01
79-2338C	5:25004	NTIS, PC A02/MF A01
79-2371C	5:23954	NTIS, PC A02/MF A01
79-2409C	5:25093	NTIS, PC A02/MF A01
80-0029C	5:24570	Dep. NTIS, PC A02/MF A01
80-0215	5:24429	NTIS, PC A03/MF A01
80-0355C	5:24583	NTIS, PC A02/MF A01
80-0359C	5:23743	Dep. NTIS, PC A02/MF A01
80-0402	5:25075	Dep. NTIS, PC A10/MF A01
80-0408C	5:24571	NTIS, PC A03/MF A01
80-0427C	5:24430	NTIS, PC A02/MF A01
80-0438C	5:25112	Dep. NTIS, PC A02/MF A01
80-0502C	5:23744	Dep. NTIS, PC A02/MF A01
80-0537	5:23538	NTIS, PC A03/MF A01
80-0670	5:24044	Dep. NTIS, PC A03/MF A01
80-0873C	5:23852	Dep. NTIS, PC A02/MF A01
80-0888C	5:24097	Dep. NTIS, PC A02/MF A01
80-0926C	5:23820	NTIS, PC A02/MF A01
80-0989C	5:24331	NTIS, PC A03/MF A01
80-1020/1	5:23745	NTIS, PC A03/MF A01
80-1020/1	5:23746	NTIS, PC A03/MF A01
80-1134	5:23620	NTIS, PC A02/MF A01
80-7022	5:23851	*See* SAN-2192-T1
80-8203	5:23858	NTIS, PC A04/MF A01
80-8215	5:24414	NTIS, PC A02/MF A01
80-8502	5:24458	NTIS, PC A03/MF A01

SERI/TP-		
331-541	5:23821	Dep. NTIS, PC A02/MF A01
333-429	5:23856	NTIS, PC A23/MF A01
333-429	5:23861	NTIS, PC A23/MF A01
333-429	5:23905	NTIS, PC A23/MF A01
333-429	5:23906	NTIS, PC A23/MF A01
333-429	5:23907	NTIS, PC A23/MF A01
333-429	5:23908	NTIS, PC A23/MF A01
333-429	5:23909	NTIS, PC A23/MF A01
333-429	5:23910	NTIS, PC A23/MF A01
333-429	5:23911	NTIS, PC A23/MF A01
333-429	5:23912	NTIS, PC A23/MF A01
333-429	5:23913	NTIS, PC A23/MF A01
333-429	5:23914	NTIS, PC A23/MF A01
333-429	5:23915	NTIS, PC A23/MF A01
333-429	5:23916	NTIS, PC A23/MF A01
333-429	5:23917	NTIS, PC A23/MF A01
333-429	5:23918	NTIS, PC A23/MF A01
333-429	5:23919	NTIS, PC A23/MF A01
333-429	5:23920	NTIS, PC A23/MF A01
333-429	5:23921	NTIS, PC A23/MF A01
333-429	5:23922	NTIS, PC A23/MF A01
333-429	5:23923	NTIS, PC A23/MF A01
333-429	5:23924	NTIS, PC A23/MF A01
333-429	5:23925	NTIS, PC A23/MF A01
333-429	5:23926	NTIS, PC A23/MF A01
333-429	5:23927	NTIS, PC A23/MF A01
333-429	5:23928	NTIS, PC A23/MF A01
333-429	5:23929	NTIS, PC A23/MF A01
333-429	5:23930	NTIS, PC A23/MF A01
333-429	5:23931	NTIS, PC A23/MF A01
333-429	5:23932	NTIS, PC A23/MF A01
333-429	5:23933	NTIS, PC A23/MF A01
333-429	5:23934	NTIS, PC A23/MF A01
333-429	5:23935	NTIS, PC A23/MF A01
333-429	5:23936	NTIS, PC A23/MF A01
333-429	5:23937	NTIS, PC A23/MF A01
333-429	5:23938	NTIS, PC A23/MF A01
333-429	5:23939	NTIS, PC A23/MF A01
333-429	5:23940	NTIS, PC A23/MF A01
333-429	5:23955	NTIS, PC A23/MF A01
333-429	5:23956	NTIS, PC A23/MF A01
333-429	5:23957	NTIS, PC A23/MF A01
333-429	5:23958	NTIS, PC A23/MF A01
334-478	5:23959	Dep. NTIS, PC A02/MF A01
334-565	5:23960	NTIS, PC A02/MF A01
623-656	5:23844	NTIS, PC A02/MF A01
641-619	5:23961	NTIS, PC A02/MF A01
641-653	5:23860	NTIS, PC A02/MF A01
731-649	5:24003	NTIS, PC A02/MF A01
SERI/TR-		
352-298	5:23853	Dep. NTIS, PC A06/MF A01
352-554	5:23776	Dep. NTIS, PC A04/MF A01
434-484	5:23799	NTIS, PC A06/MF A01
8052-1	5:23962	NTIS, PC A15/MF A01
SIU-IVI-		
110	5:23837	NTIS, PC A04/MF A01
SLAC-		
228	5:24634	NTIS, PC A03/MF A01
SMHI-HBF-PM-		
229	5:24001	Dep. NTIS (US Sales Only), PC A02/MF A01
SOLAR/0010-		
80/04	5:23797	Dep. NTIS, PC A11/MF A01
SOLAR/2028-		
78/14	5:23941	NTIS, PC A03/MF A01
SRO-		
1015-T1	5:23838	Dep. NTIS, PC A02/MF A01
TAC-HP-		
79-003	5:24512	University of New Mexico, Albuquerque
TE-		
4234-37-80	5:24336	Dep. NTIS, PC A11/MF A01
TR-		
209	5:23428	*See* METC-8450-T1
3459-1	5:24042	*See* ALO-75
UCID-		
18334	5:24981	Dep. NTIS, PC A04/MF A01
18588	5:25076	Dep. NTIS, PC A02/MF A01
18614	5:25050	Dep. NTIS, PC A02/MF A01
18615	5:25051	NTIS, PC A03/MF A01
18618	5:23639	Dep. NTIS, PC A04/MF A01
18620	5:25113	NTIS, PC A03/MF A01
18621	5:24209	NTIS, PC A02/MF A01
18622	5:24572	NTIS, PC A02/MF A01
18623	5:24982	Dep. NTIS, PC A02/MF A01
18626	5:24538	NTIS, PC A04/MF A01
18651	5:23747	NTIS, PC A02/MF A01
18652	5:24654	NTIS, PC A07/MF A01
18660	5:23710	Dep. NTIS, PC A04/MF A01
18664	5:23748	NTIS, PC A04/MF A01
18665	5:23749	NTIS, PC A03/MF A01
UCLA-ENG-		
7941	5:24080	*See* ALO-81
7967	5:24662	*See* ALO-80
UCRL-		
15094	5:23995	Dep. NTIS, PC A09/MF A01
15220	5:24784	NTIS, PC A03/MF A01
15221	5:24785	Dep. NTIS, PC A02/MF A01
15224	5:23612	Dep. NTIS, PC A04/MF A01
15226	5:24186	Dep. NTIS, PC A02/MF A01
15228	5:23750	Dep. NTIS, PC A06/MF A01
15229	5:23751	Dep. NTIS, PC A08/MF A01
15232	5:23752	Dep. NTIS, PC A05/MF A01
15234	5:24791	Dep. NTIS, PC A02/MF A01
15241	5:24348	NTIS, PC A03/MF A01
52902	5:24048	NTIS, PC A03/MF A01
52909	5:24782	NTIS, PC A20/MF A01
52923	5:25005	Dep. NTIS, PC A02/MF A01
52932	5:24770	NTIS, PC A03/MF A01
81919	5:25077	NTIS, PC A02/MF A01
82530	5:23760	NTIS, PC A02/MF A01
83583	5:24635	Dep. NTIS, PC A02/MF A01
83727	5:24584	NTIS, PC A02/MF A01
83805	5:24995	NTIS, PC A02/MF A01
83928	5:23765	Dep. NTIS, PC A02/MF A01
84018	5:25064	NTIS, PC A02/MF A01
84044(Rev.1)	5:25018	Dep. NTIS, PC A03/MF A01
84221	5:25006	Dep. NTIS, PC A02/MF A01
84245	5:25045	NTIS, PC A03/MF A01
84270	5:24983	NTIS, PC A02/MF A01
84295	5:24573	NTIS, PC A02/MF A01
84327	5:24517	NTIS, PC A03/MF A01
84370	5:24927	NTIS, PC A02/MF A01
UCRL-Trans-		
1592	5:24549	NTIS, PC A02/MF A01
11542	5:24371	NTIS, PC A02/MF A01
UMTA-MA-		
06-0049-79-10	5:24284	NTIS
UR-		
3490-1559	5:24695	Dep. NTIS, PC A10/MF A01
3490-1798	5:24771	Dep. NTIS, PC A10/MF A01
3490/LCP-20	5:24736	Dep. NTIS, PC A11/MF A01
UWFPP-		
6	5:23766	Dep. NTIS, PC A15/MF A01
7	5:25078	NTIS, PC A04/MF A01
Y-		
2205	5:24491	NTIS, PC A02/MF A01

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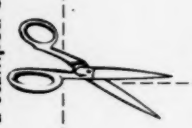

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